HIGHLIGHTS

REVISION NO. 33 Jun 01/10

Pages which have been revised are outlined below, together with the Highlights of the Revision

CH/SE/SU C PAGES	REASON FOR CHANGE	EFFECTIVITY

CHAPTER 80

L.E.P. 1- 1 Revised to Reflect this revision indicating new,revised, and/or deleted pages

CHAPTER 80

STARTING

LIST OF EFFECTIVE PAGES

N, R or D indicates pages which are New, Revised or Deleted respectively
Remove and insert the affected pages and complete the Record of Revisions and the Record of Temporary Revisions as necessary

CH/SE/SU	C	PAGE	DATE
RECORD			
OF TEMP.			
REVISION			
L.E.P.	R	1- 1	Jun01/10
T. of C.		1	Jun01/04
80-00-00		1	Jun01/04
80-00-00		2	Jun01/04
80-00-00		3	Jun01/04
80-00-00		4	Jun01/04
80-00-00		5	Jun01/04
80-00-00		6	Jun01/04
80-00-00		7	Jun01/04
80-00-00		8	Jun01/04
80-00-00		201	Jun01/04
80-00-00		202	Jun01/04
80-00-00		203	Jun01/04
80-00-00		204	Jun01/04
80-10-00		1	Jun01/04
80-10-00		2	Jun01/04
80-10-00		3	Jun01/04
80-11-00		1	Jun01/04
80-11-00		2	Jun01/04
80-11-00		3	Jun01/04
80-11-00		4	Jun01/04
80-11-00		5	Jun01/04
80-11-00		6	Jun01/04
80-11-00		7	Jun01/04
80-11-00		8	Jun01/09
80-11-00		9	Jun01/04
80-11-00		10	Jun01/04
80-11-00		11	Dec01/06
80-11-00		12	Dec01/06
80-11-00		13	Dec01/06
80-11-00		901	Jun01/05
80-13-00		1	Jun01/04
80-13-00		2	Jun01/04
80-13-00		3	Jun01/04
80-13-00		4	Jun01/04
80-13-00		5	Jun01/04
80-13-00		901	Jun01/05
80-13-00		902	Jun01/05
80-13-00		903	Jun01/04
80-13-00		904	Jun01/04
80-13-01		401	Jun01/09
80-13-01		402	Jun01/09
80-13-01		403	Jun01/09
80-13-01		404	Jun01/04
80-13-01		405	Jun01/09
80-13-01		406	Jun01/09
80-13-01		407	Jun01/04
80-13-01		601	Jun01/07
80-13-01		602	Jun01/07
80-13-01		603	Jun01/07
80-13-01		604	Jun01/07
80-13-01		605	Jun01/07
80-13-02		401	Jun01/04
80-13-02		402	Jun01/04
80-13-02		403	Jun01/04
80-13-03		401	Jun01/04
80-13-03		402	Jun01/04
80-13-03		601	Jun01/04
80-13-03		602	Jun01/04
80-13-04		401	Jun01/08
80-13-04		402	Jun01/04
80-13-04		403	Jun01/04
80-13-07		201	Jun01/04
80-13-07		202	Jun01/04
80-13-08		401	Jun01/04
80-13-08		402	Jun01/04
80-13-08		403	Jun01/04
80-13-08		404	Jun01/04
80-13-08		405	Jun01/04
80-13-08		406	Jun01/04
80-13-08		601	Jun01/04
80-13-08		602	Jun01/04
80-13-09		401	Jun01/04
80-13-09		402	Jun01/04
80-13-10		401	Jun01/04
80-13-10		402	Jun01/04

CHAPTER 80

STARTING

TABLE OF CONTENTS

SUBJECT	CH/SE/SU	C	PAGE	EFFECTIVITY
STARTING - GENERAL	80-00-00			
Description and Operation			1	101-200,
Maintenance Practices			201	101-200,
Manual Operating Starter Shut-Off Valve			201	101-200,
CRANKING	80-10-00			
Description and Operation			1	101-200,
Air Supply			1	101-200,
CONTROL AND INDICATING	80-11-00			
Description and Operation			1	101-200,
Component Location			5	101-200,
Deactivation/Reactivation			901	101-200,
Ref. : MMEL Sect. 1-80, Item 1 (Start Valve "OPEN" lt.)			901	101-200,
PNEUMATIC STARTER AND VALVE SYSTEM	80-13-00			
Description and Operation			1	101-200,
Pneumatic Starter			1	101-200,
Starter Shutoff Valve			2	101-200,
Pneumatic Starter Air Supply Duct			2	101-200,
Deactivation/Reactivation			901	101-200,
Ref. : MMEL Sect. 1-80, Item 2 (Starter Valve System)			901	101-200,
PNEUMATIC STARTER ASSEMBLY	80-13-01			
Removal/Installation			401	101-200,
Inspection/Check			601	101-200,
PNEUMATIC STARTER SHUTOFF VALVE	80-13-02			
Removal/Installation			401	101-200,
THRUST REVERSER GROUND SUPPLY PNEUMATIC COUPLING	80-13-03			
Removal/Installation			401	101-200,
Inspection/Check			601	101-200,
PNEUMATIC STARTER QUICK-ATTACH-DETACH (QAD) ADAPTER ASSEMBLY	80-13-04			
Removal/Installation			401	101-200,
ENGINE START VALVE FILTER	80-13-07			
Maintenance Practices			201	101-200,
PNEUMATIC STARTER AIR SUPPLY DUCT	80-13-08			
Removal/Installation			401	101-200,
Inspection/Check			601	101-200,
PNEUMATIC STARTER COOLING AIR TUBE	80-13-09			
Removal/Installation			401	101-200,
PNEUMATIC STARTER HEATSHIELD ASSEMBLY	80-13-10			
Removal/Installation			401	101-200,

STARTING - GENERAL - DESCRIPTION AND OPERATION

1. General (Ref. Fig. 003, 004)
(Ref. Fig. 001)
(Ref. Fig. 002)

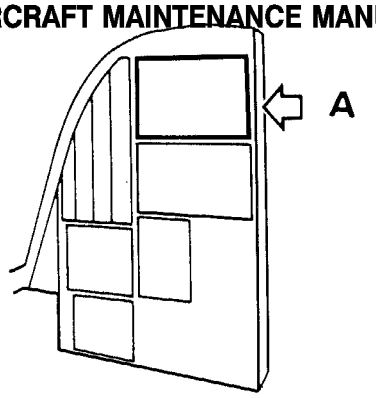
A. The starting system ensures normal engine starts and in flight restarts.

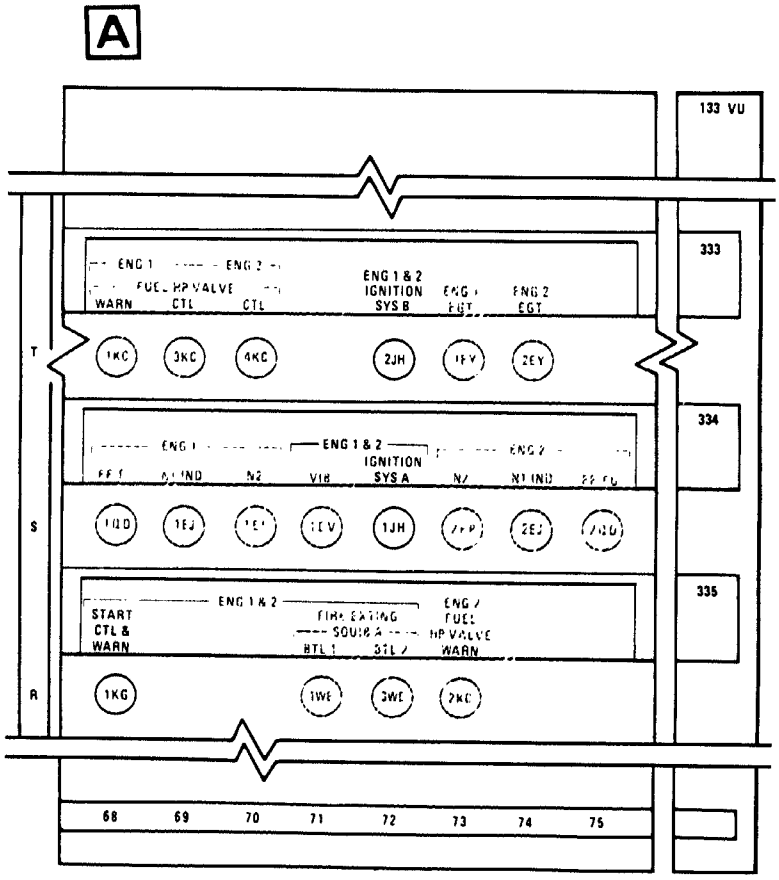
B. - The engine starter utilizes pressurized air to crank the HP rotor up to a sufficient speed to ensure :
  - a good air/fuel mixture when the HP fuel shut-off valve is open.
  - a positive acceleration of the engine
- The pneumatic power source can be :
  - either an external ground power unit
  - or the APU
  - or the other engine (via the pneumatic cross bleed valve).

C. To monitor the starting procedure, the crew controls the air supply with a start valve positioned upstream of the starter. It is a pneumatically operated valve, with electrical control. However in case of failure, the valve can be opened manually on ground by the maintenance personnel.
WARNING : **WHEN WALKING AWAY FROM THE ENGINE AFTER MANUAL OPERATION OF THE START VALVE, BE CAREFULL TO KEEP AWAY FROM DANGEROUS ZONES.**

D. The flight crew can monitor the engine starting procedure from the the ENG overhead panel.
The start sequence will be automatically ended when the engine reaches N2 = 4455 RPM (45%); at this speed, an electrical signal is sent by the RPM N2 indicator to close the start valve. In case of failure of this signal, the starter will automatically be disengaged by centrifugal force when N2 exceeds 45%. The starter is also used to crank the engine when only wet (HP fuel shut off valve open) or dry (HP fuel shut off valve shut) motoring is required. The same procedure can be used for in flight relight. In these conditions, the starter reengagement will not be done with N2 > 20%.

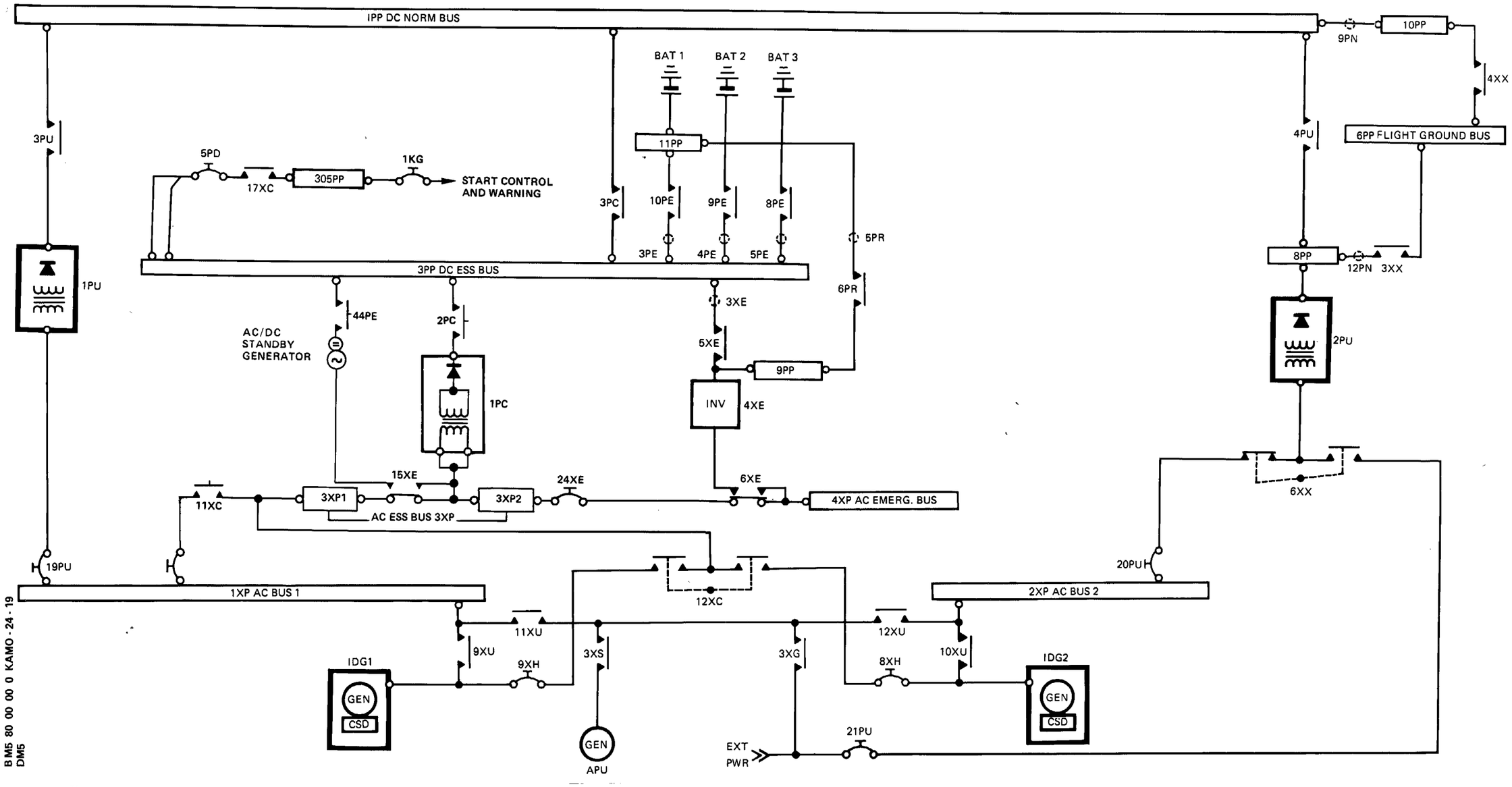
2. Function (Ref. Fig. 005, 006)



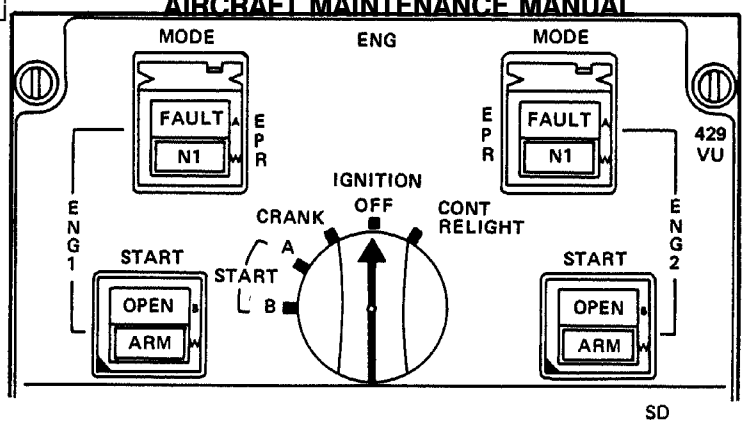


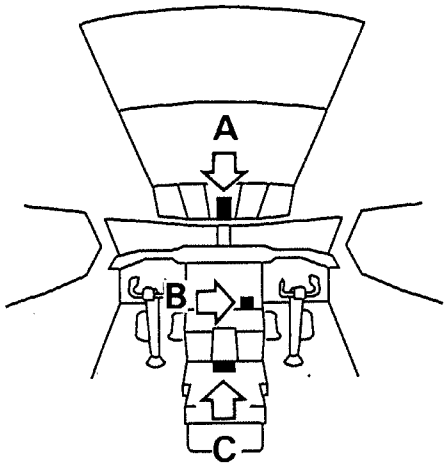
BM5 80 00 00 0 KEMO 19

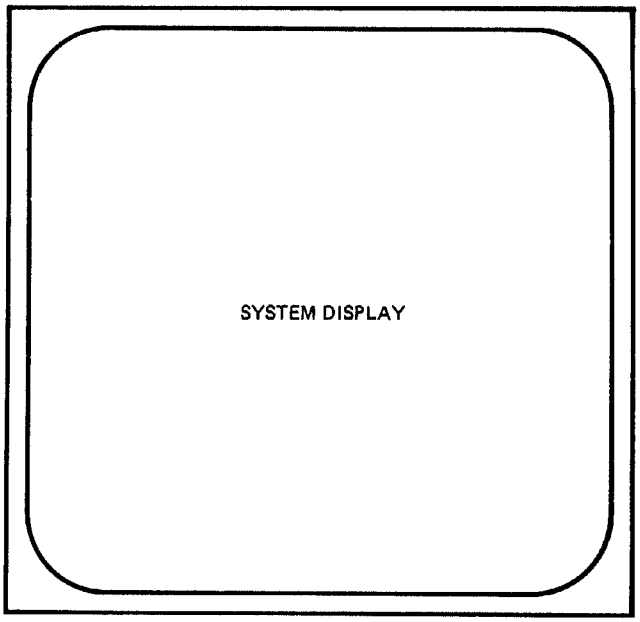
Circuit Breaker Panel 133VU - Component Location
Figure 001



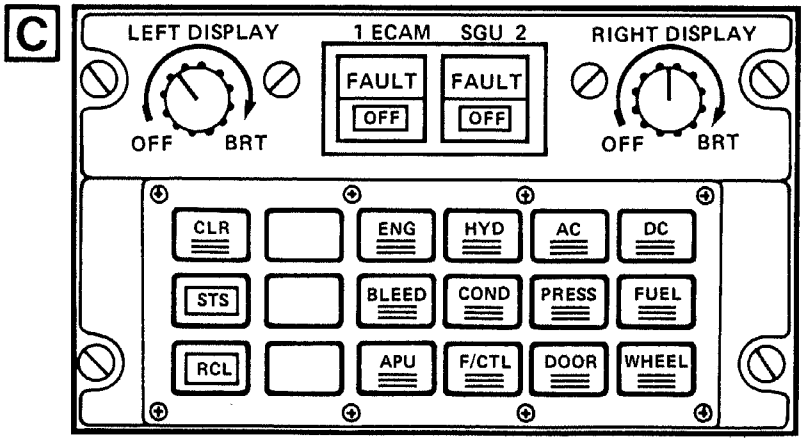
Starting - Electrical Circuit
Figure 002





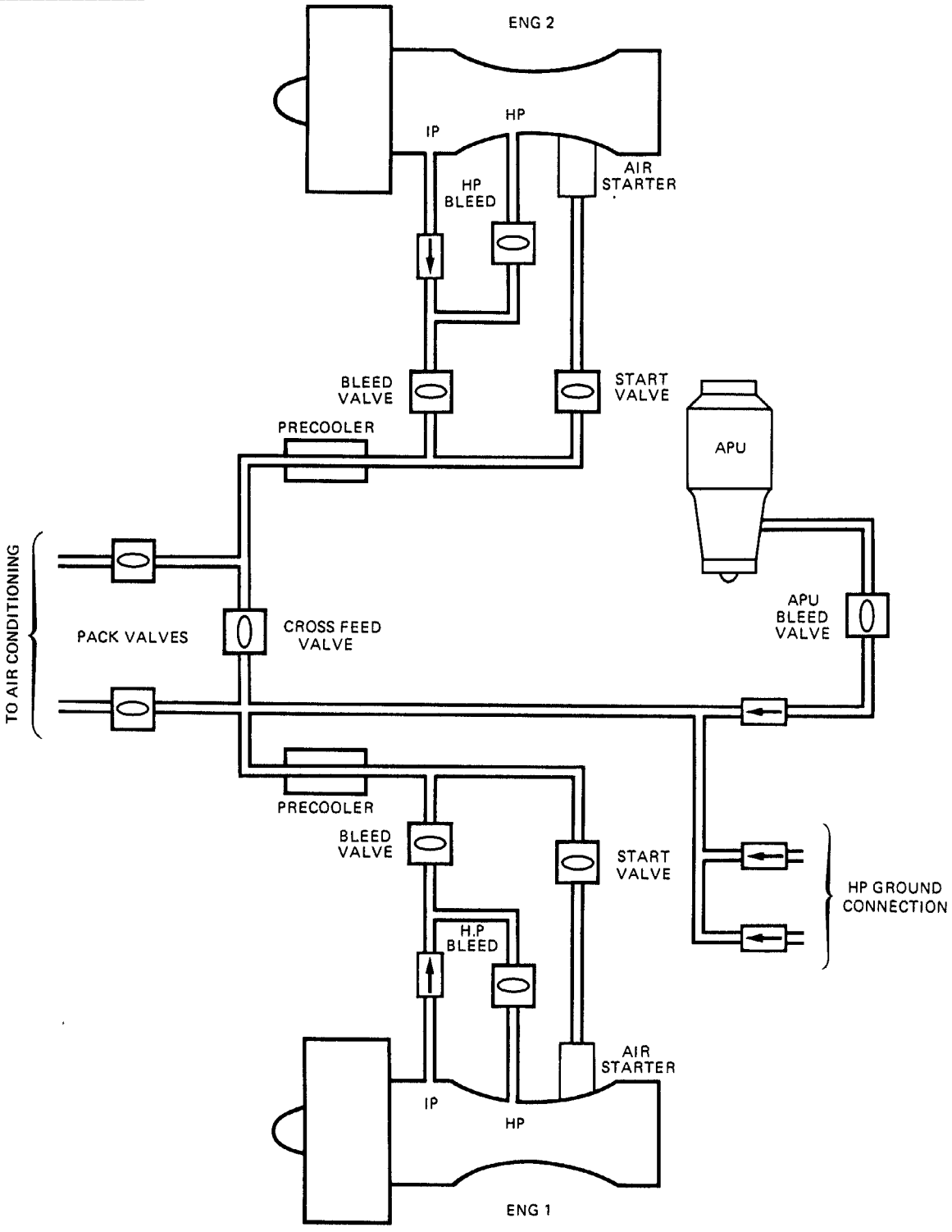


ECAM CONTROL PANEL



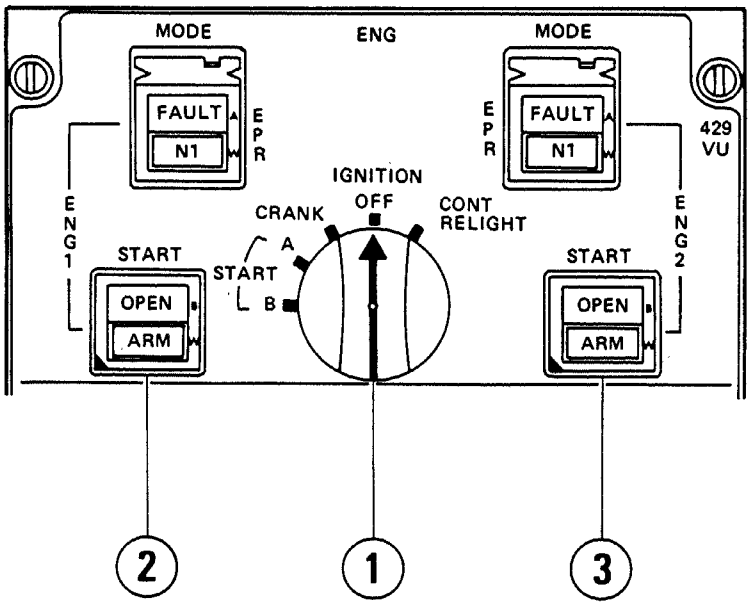
BM5 80 00 00 0 KCMO - 00

Controls and Indicators - Component Location
Figure 003



BM5 80 00 00 0 KGMO 19

Starter - Pneumatic Air Supply
Figure 004



A. ENG. IGNITION SELECTOR SWITCH (1)
WHEN THE IGNITION MODE (CRANK, START A, START B, CONT RELIGHT) IS SELECTED, OPERATION OF OPEN / ARM SWITCH IS AUTHORIZED.

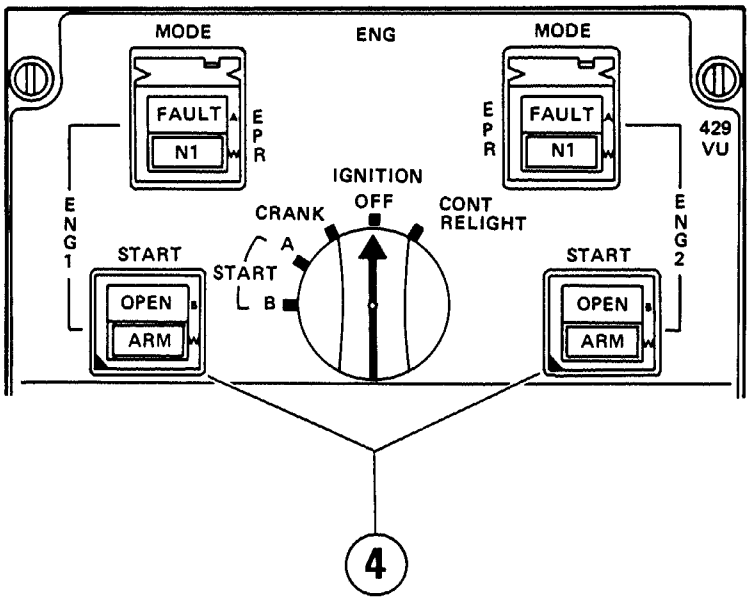
B. OPEN / ARM PUSHBUTTON SWITCH (2) (ENG. 1)
IT IS USED TO INITIATE THE START SEQUENCE.
RELEASED: (NORMAL POSITION)
THE ARM LEGEND (WHITE) COMES ON IF ENG IGNITION SELECTOR IS NOT IN OFF POSITION.
PRESSED:
THE ARM LEGEND (WHITE) GOES OFF.
THE FUEL USED INDICATION ENG. 1 IS RESET TO ZERO (ON GROUND ONLY)
THE OPEN LEGEND (BLUE) COMES ON, SHOWING THE START VALVE OPENING.
WHEN N2 REACHES 45% OPEN / ARM PUSHBUTTON RELEASES AND
THE OPEN LEGEND GOES OFF. WHEN THE START VALVE IS FULLY CLOSED.

C. OPEN / ARM PUSHBUTTON SWITCH (3) (ENG. 2)
AS PARAGRAPH B ABOVE.

D. WHEN BOTH ENGINES N2 ARE ABOVE 45% BOTH ARM LEGENDS ILLUMINATE AGAIN TO INDICATE THAT THE SELECTOR SWITCH SHOULD BE PUT BACK TO THE OFF POSITION.

BM5 80 00 00 0 KJM0 01

ENG Panel
Figure 005



E. START PUSHBUTTON SWITCH OPEN LEGEND ON (BLUE) (4) COMES ON WHEN THE START VALVE IS NOT IN FULLY CLOSED POSITION. THIS INDICATION IS INDEPENDENT OF ENG IGNITION SELECTOR SWITCH AND PUSHBUTTON SWITCH POSITIONS.

BM5 80 00 00 0 KLMO .19

ENG Panel
Figure 006

1. Manual Operating Starter Shut-Off Valve

This procedure gives instruction for manually opening or closing a failed pneumatic starter shut-off valve during engine starting or engine motoring.

A. Equipment and Materials

ITEM	DESIGNATION
A.	Warning Notice
Referenced Procedures	
- 71-00-00, P. Block 201	Power Plant
- 71-00-00, P. Block 501	Power Plant

B. Procedure

WARNING : WHEN WALKING AWAY FROM THE ENGINE AFTER MANUAL OPERATION OF THE START VALVE, BE CAREFUL TO KEEP AWAY FROM DANGEROUS ZONES. (REF. 71-00-00, P. BLOCK 201).

WARNING : EAR AND EYE PROTECTIVE EQUIPMENT MUST BE WORN BY PERSONNEL WORKING NEAR AIRCRAFT WHILE ENGINES ARE RUNNING.

(1) Job set-up

(a) Establish communications between ground crew and flight compartment.

NOTE : There is possibility to have an intercommunication between ground crew and flight compartment during engine motoring by using the appropriate phone jack.

(b) Access to the manual override is via a hole on right reverser cowl at 5 o'clock.

(2) Opening of valve (Ref. Fig. 201, 202)

(a) In flight compartment prepare, service and start engine (Ref. 71-00-00, P. Block 201) or engine motoring (Ref. 71-00-00, P. Block 501) and press OPEN/ARM pushbutton switch.

(b) Tell ground crew to open valve.

CAUTION : WHEN EXERCISING START VALVE, MANUALLY MAINTAIN A FIRM AND POSITIVE OPENING ACTION SO AS TO PREVENT CLOSING VALVE INADVERTENTLY (SPRING LOADED) AND TO PREVENT ANY POSSIBILITY OF STARTER CRASH REENGAGEMENT.

(c) On ground, by means of a 3/8 drive square, rotate valve (counterclockwise) to open and maintain.

(d) When valve is open.

1 On engine overhead panel 429VU, the OPEN legend (blue) comes on.
2 Starter is engaged.

(3) Closing of valve (Ref. Fig. 201, 202)

(a) Failure during engine starting

1 When N2 = 45 % tell ground crew to close valve.
2 On ground release manual override to close valve (spring-loaded).
3 When valve is closed.
- On engine overhead panel 429VU, the open legend (blue) goes off.
- Starter is disengaged.

(b) Failure during engine motoring.

1 On overhead panel 429VU, place ignition selector switch in OFF

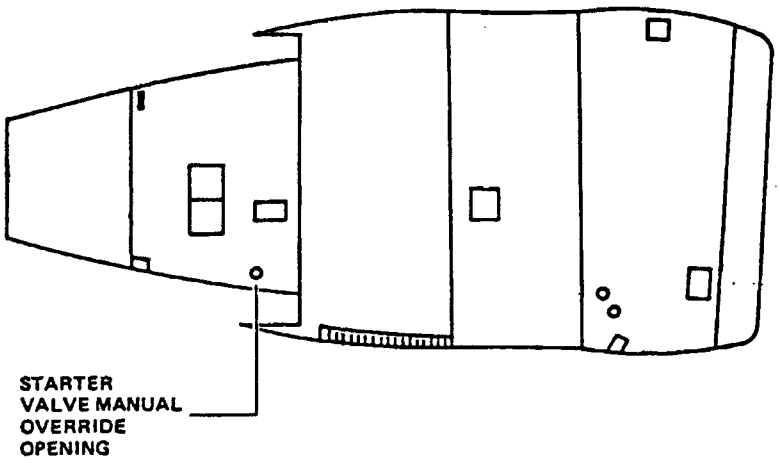
position.

2 Tell ground crew to close valve.
On ground, release manual override to close valve.

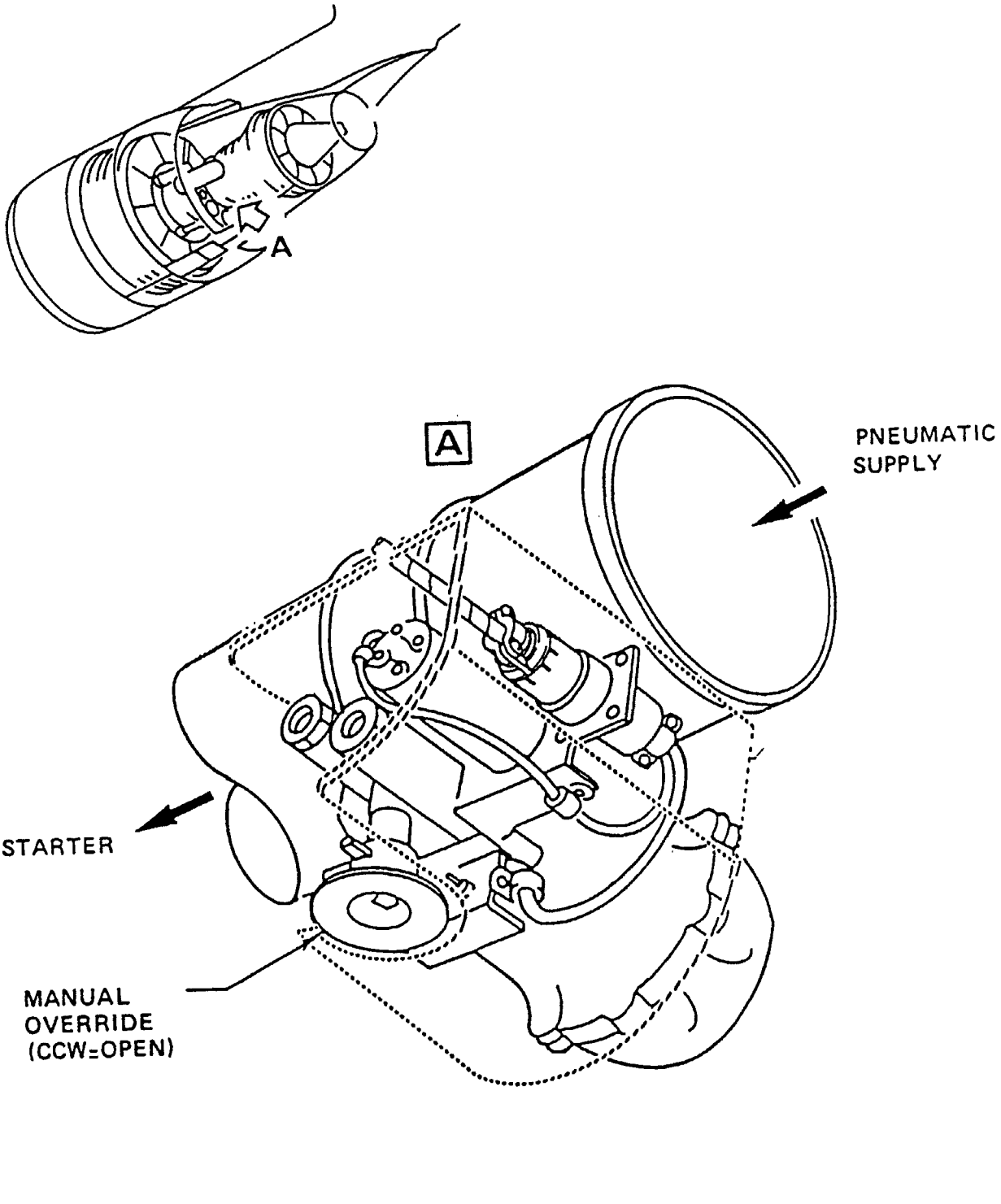
3 When valve is closed.
- On engine overhead panel 429VU, the OPEN legend (blue) goes off.
- Starter is disengaged.

(4)Close-up

1 Install a warning notice in flight compartment indicating that ENG1(2) pneumatic starter shut-off valve is inoperative.



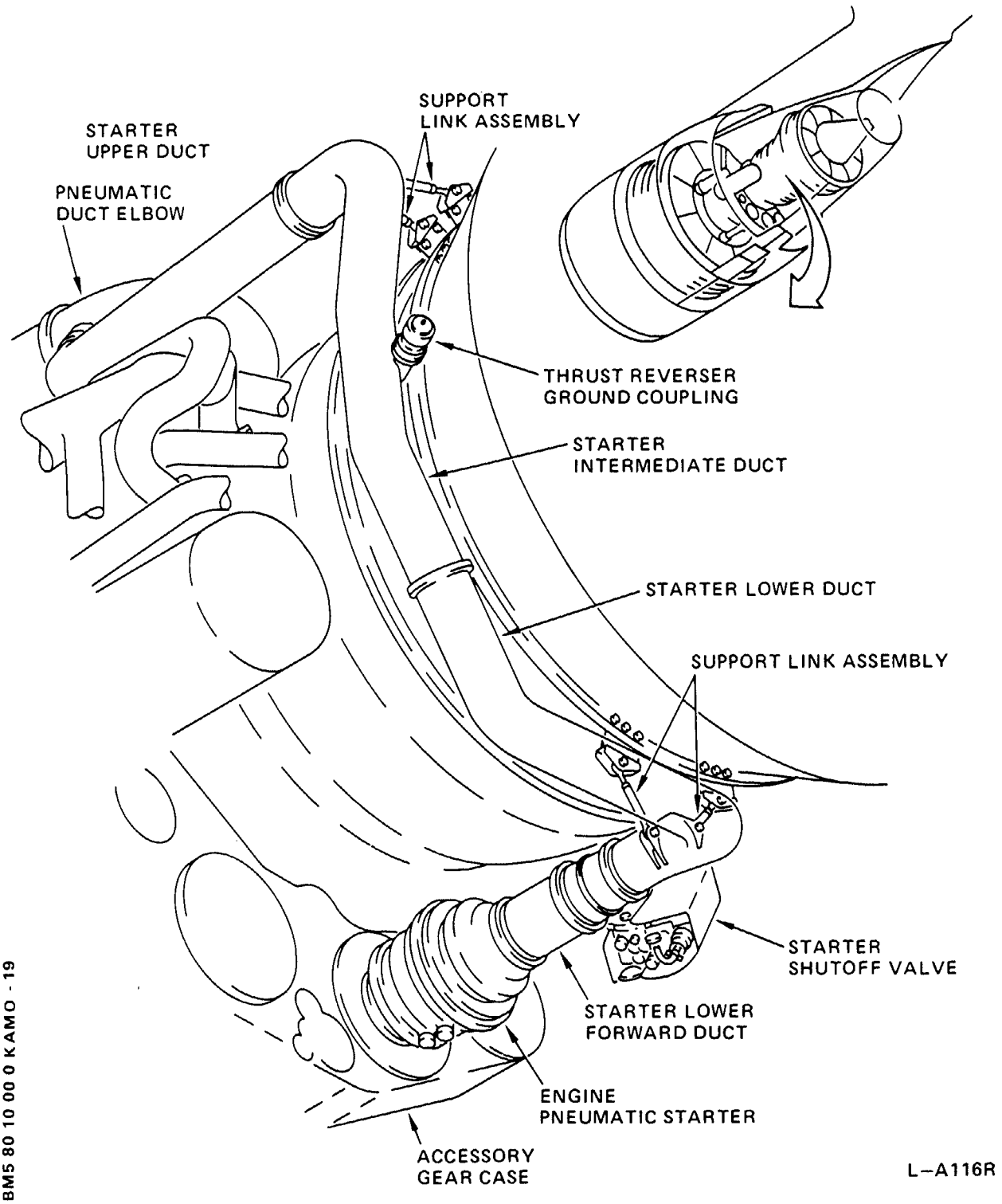
Starter Valve
Figure 201



Starter Valve Manual Override Opening
Figure 202

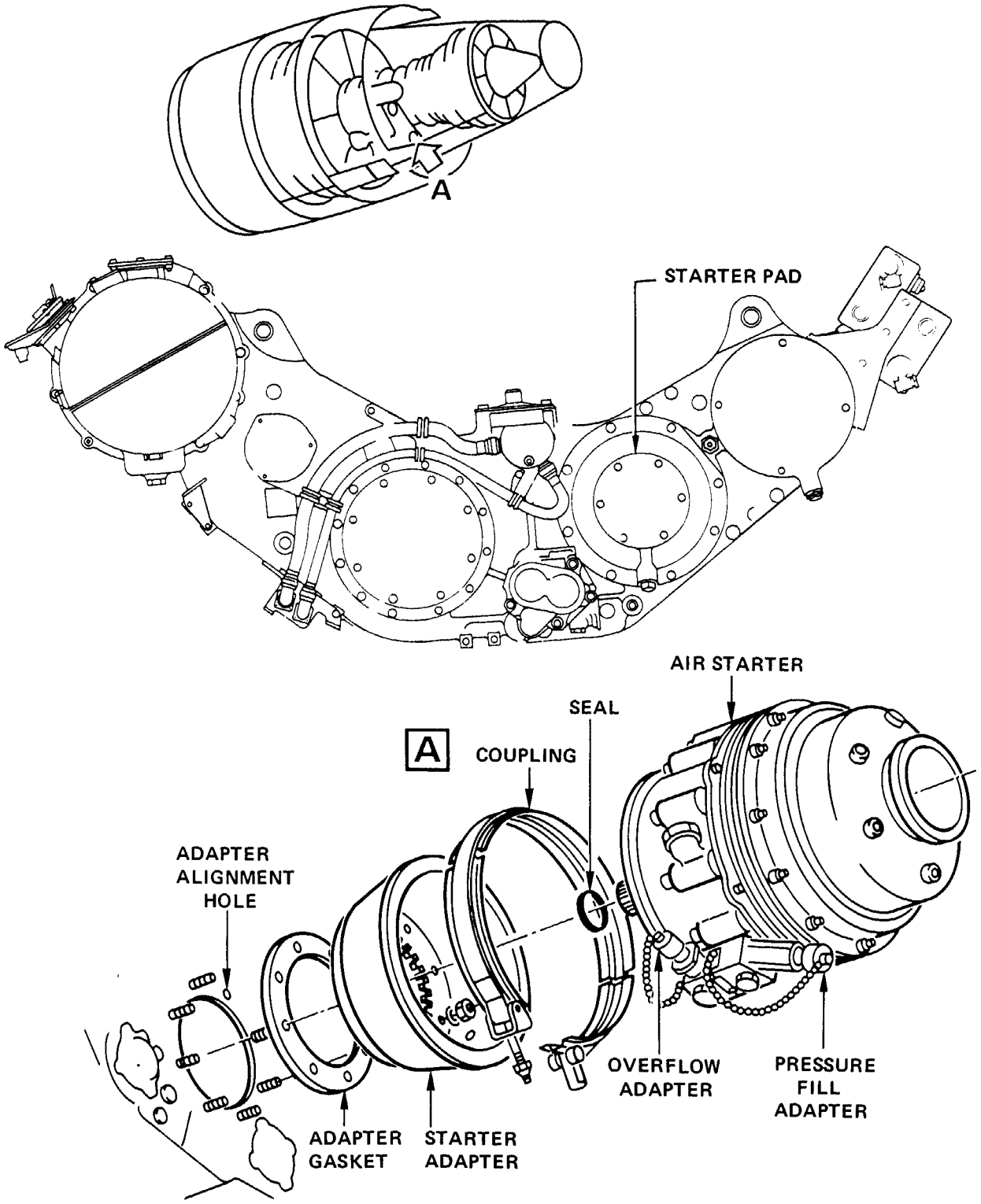
CRANKING - DESCRIPTION AND OPERATION

1. Air Supply (Ref. Fig. 001, 002)
   The pneumatic power necessary to air starter can be supplied from :
   starter with a corrected airflow of 94 ± 3lb/mn (0.71 ± 0.02 kg/s).
   This pneumatic power can be supplied from :
   - either the aircraft APU (which will be used in MES mode)
   - or an external ground power unit (via an aircraft ground connector)
   - or the other engine
   In this case, the air is routed through the open cross bleed valve to the start valve of starting engine by a 4 in. outer dia. pipe on the left hand side of the core. The starter is located at the bottom of the rear side of the accessory gearbox and the reduction gear ratio of the engine pad is 0.841/1.



BM5 80 10 00 0 KAMO - 19

Starter Pneumatic Supply
Figure 001



Starter Installation
Figure 002

1. Description

(Ref. Fig. 001)

For both engines, starting is controlled from **ENG** panel located on overhead panel **429VU**.

Both engine start valves and ignition (Ref. 74-00-00) system are controlled from this panel.

Every time a starting sequence is initiated the Engine page is called on the **RH ECAM** display unit.

This panel has the following items of equipment :

- **START ENG1 (ENG2)** :

  When pressed the following actions are initiated :

  . energization of the start valve solenoid which allows opening of the start valve

  . reset to zero of the fuel used indication of the engine 1 (2) (on ground only)

  . **APU** speed raised to **MES**

  When this start valve leaves the closed position the blue **OPEN** light comes on.

  When the engine reaches **N2 = 45 %** the pushbutton switch is automatically released and the valve closes. The blue **OPEN** legend goes off when the valve is fully closed.

- **ENG IGNITION** selector switch

  The **ENG IGNITION** selector switch allows the crew to select one of the following positions :

  . **CONT RELIGHT** : in this position both igniters of both engines are activated as long as the selector switch is in this position (Ref. 74-00-00)

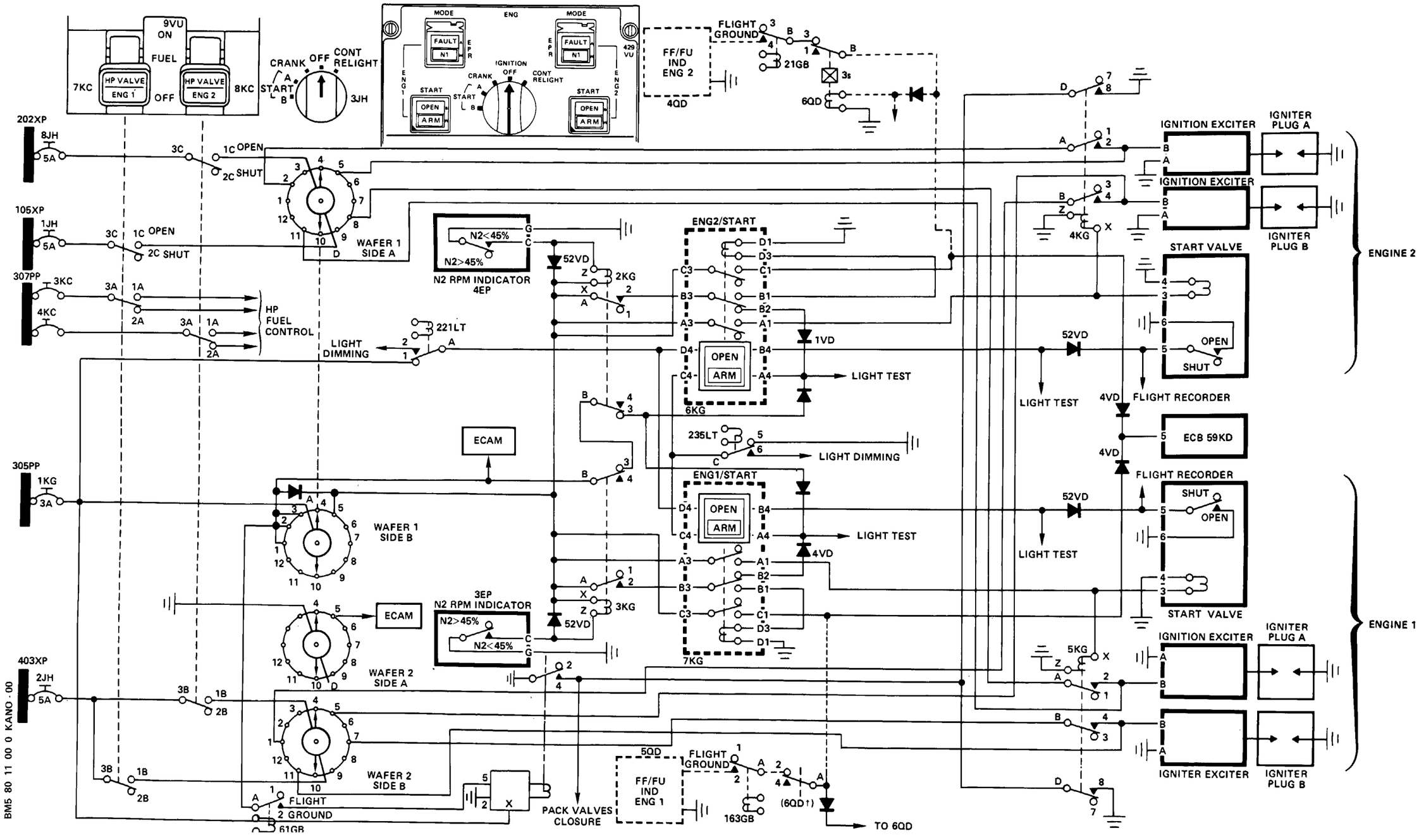
  . **OFF** : this position is the normal position when no ignition, no starter usage are needed.
  This position cuts off power supply to all igniters and start valve solenoids.

  . **CRANK** : this is the position to be used for wet and dry motoring of either engine.
  In this position, the igniters are not powered, however the **ENG START** pushbutton switches can be activated.

  . **START A** : this position activates the ignition system **A** for both engines as well as the corresponding start valve provided that **ARM** is selected on **ENG START** pushbutton swith. This ignition system is activated when the **HP** fuel shut off valve is open and remains operational as long as **N2 < 45 %. A > 45 %** signal coming from the **N2 RPM** indicator will deactivate the start valve and the ignition system.

  . **START B** : this position is identical to **START A**, with the only exception that now both **B** ignition systems are activated.

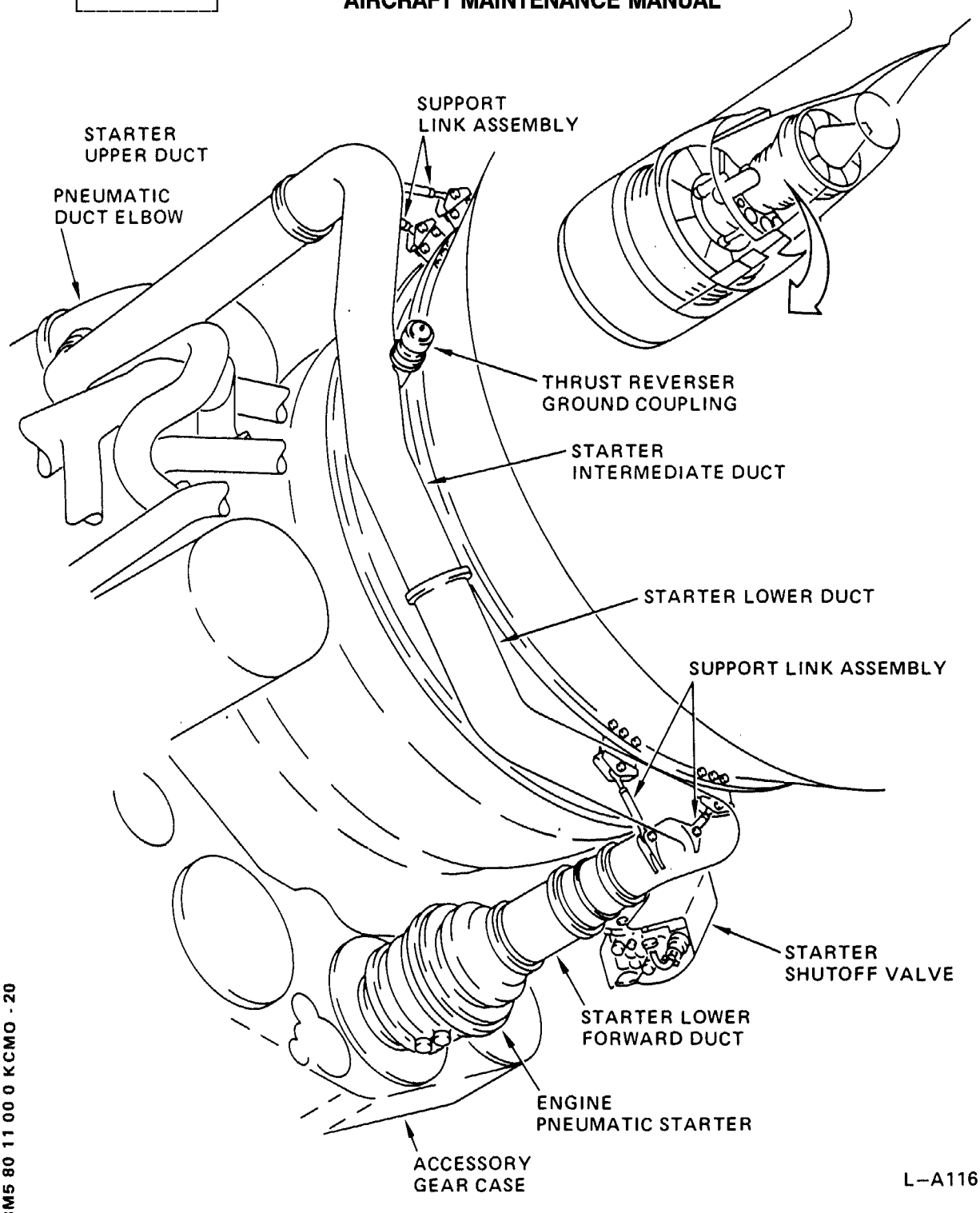
INTENTIONALLY BLANK



Electrical Circuit - Ignition Starting
Figure 001

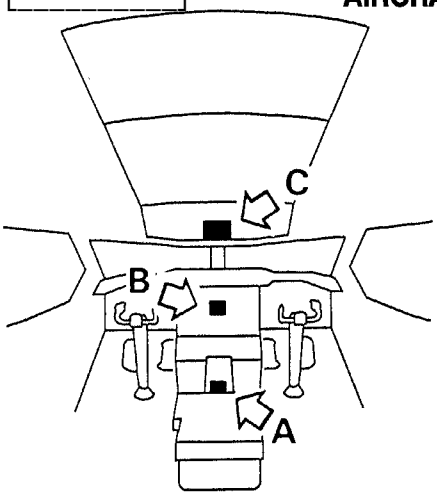
2. Component Location
(Ref. Fig. 002, 003)

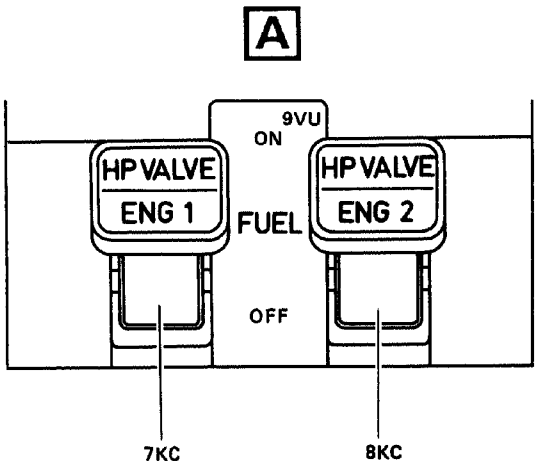
FIN	FUNCTIONAL DESIGNATION	PANEL	ZONE	ACCESS DOOR	ATA REF.
215V	VALVE-PNEUMATIC		451	451AL	80-13-02
	STARTER, ENG1 (ENG2)		461	461AL	
	PNEUMATIC COUPLING-THRUST REVERSER		451	451AL	80-13-03
	GROUND SUPPLY		461	461AL	
	FILTER-ENGINE START VALVE		451	451AL	80-13-07
			461	461AL	
	DUCT-PNEUMATIC STARTER ENG1 (ENG2)		451	451AL	80-13-08
			461	461AL	
3JH	SWITCH-ENG IGNITION SEL	429VU	211		74-00-00
					80-11-00
7KG	P/BSW-ENG1/START	429VU	211		74-00-00
					80-11-00
6KG	P/BSW-ENG2/START	429VU	211		74-00-00
					80-11-00
7KC	LEVER-HP FUEL SHUT OFF VALVE CTL, ENG1	9VU	211		76-12-11
8KC	LEVER-HP FUEL SHUT OFF VALVE CTL, ENG2	9VU	211		76-12-11
3EP	IND-N2, ENG1	4VU	211		77-00-00
					80-11-00
4EP	IND-N2, ENG2	4VU	211		77-00-00
					80-11-00

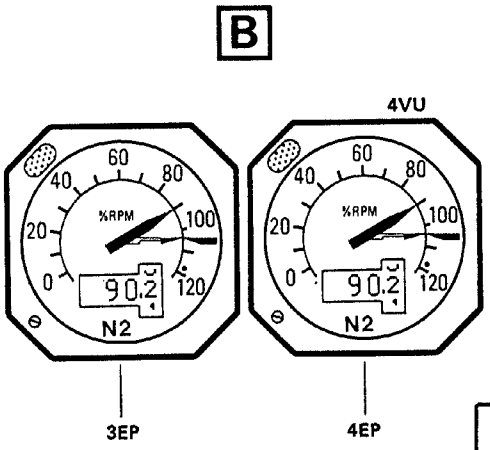


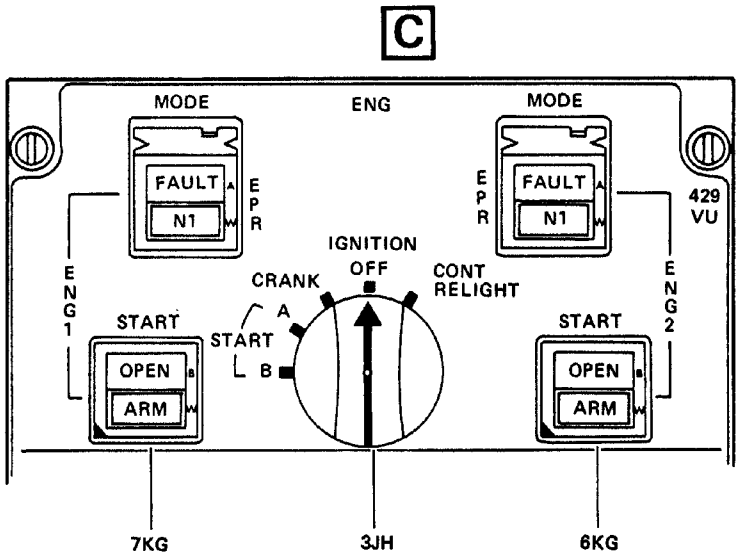
BM5 80 11 00 0 KCMO - 20

Engine Start - Component Location
Figure 002









BM5 80 11 00 0 KEMO - 00

Control and Indicating - Component Location
Figure 003

3. Operation

A. The ENG panel has to be used in the following conditions :
(1)On ground for :
(a)Engine dry motoring.
(b)Engine wet motoring.
(c)Engine starting.
(2)In flight for :
(a)In flight relight with starter assistance.
(b)In flight relight without starter assistance.

B. Utilization on Ground
WARNING : BEFORE ANY ATTEMPT TO RUN AN ENGINE (MOTORING OR START), BE CAREFUL THAT THE VICINITY OF THE ENGINE IS FREE FROM ANY OBJECT WHICH CAN BE INGESTED OR DAMAGED BY THE RUNNING ENGINE.
Check that a suitable source of pneumatic power is avalaible (APU, ground power unit, other engine with cross bleed valve open).
(1)Starter duty cycle limitations
R (a)Duty cycle limits
R - Normal duty cycle is two consecutive aborted start attempts.
R - Engine motoring for 30 seconds is required following an aborted start.
R - After 2 aborted start attempts, a 30-minute starter cooling down period must be observed prior to further starter operation.
R (b)Re-engagement speed limits
R - Normal re-engagement speed : 15 percent N2.
R - Maximum re-engagement speed : 30 percent N2.
(c)Extended starter duty cycles and cooling requirements for engine motoring with fuel and ignition OFF are :
1 0 - 5 minutes ON - Disengage starter and allow N2 speed to go to zero before re-engaging starter.
2 5 - 10 minutes ON followed by a 10-minute starter cooling period.
3 10 - 15 minutes ON followed by a 15-minute starter cooling period
(2)Dry motoring
Place ENG IGNITION selector switch in the CRANK position, this causes the ARM legends of START ENG1 and START ENG2 pushbutton switches to come on.
Press the requested START pushbutton switch ; the ARM legend goes off as soon as the valve leaves the fully closed position the OPEN blue legend comes on.
The starter receives pneumatic power and provides torque to the engine gear train, rotating the engine rotor at a speed of 10 to 20 % N2.
When all conditions for dry motoring are met, stop it by pressing to release the START pushbutton switch, this causes the valve to close.
When the valve is fully closed, the blue OPEN legend goes off.
The dry motoring is limited as described in starter duty cycle limitation (See step (1).
(3)Wet motoring
The procedure is exactly the same as for a dry motoring, with the exception that at N2 = 15 %, the HP fuel shut off valve is open and the exhaust nozzle shall be monitored to detect any fuel discharge through the fuel nozzle and combustion chamber.

At the end of the wet motoring sequence, return the HP fuel shut off valve control lever to the OFF position and continue motoring the engine for at least 30 seconds, or until all traces of fuel vapors have disappeared from the engine exhaust nozzle. To stop motoring press to release the START ENG1 (ENG2) pushbutton switch. When the valve is fully closed, the blue OPEN legend goes off.
Taking into account that the starter utilization time must not exceed starter duty cycle limitations. In all cases the HP fuel shut off valve will be returned to OFF and the engine will be motored for at least 30 seconds to eliminate trapped fuel or vapor.
For initial start after wet motoring, a minimum of 10 mn at ground idle is required.

(4)Engine start

- select the START A (or START B) position. This operation will allow the selected igniter circuit to be energized, as soon as the HP fuel shut off valve is open. This operation will set up the aircraft air conditioning system for the engine start procedure (both packs will be closed and APU speed will rise to MES status). Check that a suitable source of pneumatic power is available. (Minimum pneumatic pressure 25 psi).
- Press the START pushbutton switch. The ARM legend goes off. This causes the start valve to open and supply air to the starter which will motor the engine core shaft. At the same time the APU will receive a signal to select MES status. As soon as the valve leaves the fully closed position, the OPEN legend comes on blue.

Monitor both EGT and RPM N2 indicators closely during the start sequence.
If EGT is above 180°C, motor the engine until the EGT falls below 180°C.
When N2 reaches a minimum of 15 %, place the HP fuel shut off valve control lever in ON position (with N2 above 20 % if possible).
Within a short lapse of time the HP fuel shut off valve opens. The EGT rises and N2 increases.

CAUTION : A SLUGGISH N2 ACCELERATION IS AN INDICATION OF AN INPENDING HOT OR HUNG START IF THIS SLOW N2 ACCELERATION IS ASSOCIATED WITH A RAPIDLY INCREASING EGT. THE START SEQUENCE WILL BE ABORTED WHEN IDLE RATING IS NOT REACHED WITHIN 120 SECONDS FROM HP FUEL SHUT OFF VALVE OPENING.

If EGT exceeds the starting temperature limit : 535°C, the engine must be shut down immediately. Continue motoring the engine to return EGT below 180°C, unless it is obvious that this operation results in damage to the engine. Record duration of overtemperature and peak value. Do not attempt a new starting procedure until corrective action has been accomplished.
The start sequence should be stopped if :

- No N1 indication is obtained immediately after an indication of EGT rise.
- The engine requires more than 120 seconds to accelerate from HP fuel shut off valve opening (i.e. control lever in ON position) to idle N2.

NOTE : This engine starting maximum time (120 s) has been defined to accomodate extreme conditions such as hot or very cold day,

high altitude airport, weak starter or APCS system, aged engine. But in normal conditions, a recent engine should reach idle in 90 seconds.

- No EGT rise is obtained, 20 seconds after placing control lever in ON position.
- Fuel or ignition is inadvertently interrupted.
- Dense fuel vapor is emitted from the exhaust nozzle for a prolonged period.

NOTE : - To stop the start sequence, place the HP fuel shut off valve control lever in OFF position; continue motoring the engine for 30 seconds to remove fuel or vapors or until EGT is reduced below 180°C.
- A steady starting fuel flow above 1000 pph (455 kg/h) at EGT rise may indicate an impending hot start.
- In the event of high tail winds the maximum motoring speed is recommended before opening HP fuel shut off valve.
- The starter may be re-engaged with an N2 speed up to 20 %.
- The fuel flow before EGT rise will decrease with ground altitude, down to a minimum value of approximately 600 pph (275 kg/h) at 2000 ft and above.

During engine motoring (dry, wet or engine start), it is necessary to check that a positive indication of oil pressure is obtained.
When the oil pressure exceeds 70 psi, the OIL LOW PRESS warning light goes off.
When N2 reaches 45 % the start valve closes automatically. Check that blue OPEN legend is extinguished when engine reaches ground idle.
When both engines are started, both ARM legends come on again.
They may be extinguished by returning the ENG IGNITION selector switch to OFF position.
If the valve remains open, the OPEN legend remains on.

C. Inflight Relight

CAUTION : DO NOT ATTEMPT, UNLESS REQUIRED FOR FLIGHT SAFETY REASONS, TO RESTART AN ENGINE WHICH HAS BEEN STOPPED FURTHER TO FAILURE.

(1)Windmilling

Windmilling is not limited in time however, if windmilling N2 exceeds 31 %, open the HP fuel shut off valve for three minutes every hour to prevent the development of excessive fuel temperature within the fuel system.
To allow the maintenance action to be correctly conducted it is necessary that the crew record the duration of windmilling whenever oil pressure was below 5 psi.

(2)Inflight starting without starter assistance

When the windmilling N2 is above 20 % it is not necessary to use the starter for engine relight
In this case the procedure is as follows :
- ENG IGNITION selector switch in CONT RELIGHT position
- HP fuel shut off valve control lever in ON position (HP fuel shut off valve open)
- close monitoring of N2 and EGT.

If N2 increases slowly and EGT increases rapidly, return the HP fuel shut

off valve control lever to the OFF position immediately.
If the EGT rise is also slow, wait 90 s. to reach idle ; if idle is not reached 90 s. after placing HP fuel shut off valve control lever in ON position return the lever to the OFF position.
If EGT on indicator exceeds 625°C, return HP fuel shut off valve control lever to the OFF position.
When N2 idle is reached, return the ENG IGNITION selector switch to the OFF position. This will deenergize the ignition system, but the engine will be self sustained. In case of bad weather conditions (heavy rain, icing conditions), keep the ENG IGNITION selector switch in CONT RELIGHT position as long as necessary keeping in mind that both ignition systems will be operative on both engines.

R **ON A/C 101-104,

R Post SB 72-2032 For A/C 101-104,

C. Inflight Relight

CAUTION : DO NOT ATTEMPT, UNLESS REQUIRED FOR FLIGHT SAFETY REASONS, TO RESTART AN ENGINE WHICH HAS BEEN STOPPED FURTHER TO FAILURE.

(1)Windmilling

Windmilling is not limited in time however, if windmilling N2 exceeds 31 %, open the HP fuel shut off valve for three minutes every hour to prevent the development of excessive fuel temperature within the fuel system.
To allow the maintenance action to be correctly conducted it is necessary that the crew record the duration of windmilling whenever oil pressure was below 5 psi.

(2)Inflight starting without starter assistance

When the windmilling N2 is above 20 % it is not necessary to use the starter for engine relight
In this case the procedure is as follows :
- ENG IGNITION selector switch in CONT RELIGHT position
- HP fuel shut off valve control lever in ON position (HP fuel shut off valve open)
- close monitoring of N2 and EGT.

If N2 increases slowly and EGT increases rapidly, return the HP fuel shut off valve control lever to the OFF position immediately.
If the EGT rise is also slow, wait 90 s. to reach idle ; if idle is not reached 90 s. after placing HP fuel shut off valve control lever in ON position return the lever to the OFF position.
If EGT exceeds 650°C, return HP fuel shut off valve control lever to the OFF position.
When N2 idle is reached, return the ENG IGNITION selector switch to the OFF position. This will deenergize the ignition system, but the engine will be self sustained. In case of bad weather conditions (heavy rain, icing conditions), keep the ENG IGNITION selector switch in CONT RELIGHT position as long as necessary keeping in mind that both ignition systems will be operative on both engines.

**ON A/C 101-200,

(3)Inflight starting with starter assistance.
If the windmilling N2 is below 20 %, it is necessary to motor the engine up to 15 % to 20 %, checking that the EGT is below 180°C.
In order to achieve these conditions, the following procedure shall be applied :
- if possible (zp below 15000 ft) start APU in order to obtain a suitable source of pneumatic power. (Minimum pneumatic pressure 25 psi).
- place ENG IGNITION selector switch in START A (or B) position. This will activate the selected ignition system as soon as the HP fuel shut off valve is open. ARM legends come on.
  This operation will set up the aircraft air conditioning system to supply maximum airflow for engine start.
  The pneumatic power will be supplied from either the APU (depending on the altitude) or the other engine (crossbleed valve open).
- Press the ENG START pushbutton switch. The ARM legend goes off. This opens the start valve and provides pneumatic power to the starter which motors the engine core shaft. The OPEN legend comes on as soon as the valve leaves the fully closed position.

If EGT is above 180°C, motor the engine to reduce EGT below 180°C.
When N2 reaches 15 % minimum, move the HP fuel shut off valve control lever to ON position (if possible, N2 shall be above 20 %). N2 will increase and EGT will rise.
CAUTION : CLOSELY MONITOR N2 AND EGT
- IF EGT ON INDICATOR EXCEEDS THE STARTING LIMIT OF 625°C, THE START SEQUENCE MUST BE ABORTED IMMEDIATELY BY RETURNING THE HP FUEL SHUT OFF VALVE CONTROL LEVER TO OFF POSITION.
- A SLUGGISH N2 ACCELERATION IS AN INDICATION OF EITHER A HOT OR HUNG START ; IF EGT RISES RAPIDLY, THE START SEQUENCE MUST BE ABORTED IMMEDIATELY ; IF EGT INCREASES SLOWLY CHECK THAT IDLE IS OBTAINED 90 S. AFTER PLACING HP FUEL SHUT OFF VALVE CONTROL LEVER IN ON POSITION ; IF THIS CONDITION IS NOT FULFILLED, THE START SEQUENCE WILL BE ABORTED IMMEDIATELY.
- CHECK THAT A POSITIVE INDICATION OF OIL PRESSURE IS OBTAINED AFTER N2 ACCELERATION.

When N2 reaches 45 %, the start valve will automatically close, the OPEN legend will go off.
Return the ENG IGNITION selector switch to the OFF position restoring the air conditioning system and APU to pre-start conditions.
Return ENG IGNITION selector switch to the OFF position.

R **ON A/C 101-104,

R Post SB 72-2032 For A/C 101-104,

(3)Inflight starting with starter assistance.
If the windmilling N2 is below 20 %, it is necessary to motor the engine up to 15 % to 20 %, checking that the EGT is below 180°C.

In order to achieve these conditions, the following procedure shall be applied :

- if possible (zp below 15000 ft) start **APU** in order to obtain a suitable source of pneumatic power. (Minimum pneumatic pressure 25 psi).
- place **ENG IGNITION** selector switch in **START A** (or **B**) position. This will activate the selected ignition system as soon as the **HP** fuel shut off valve is open. **ARM** legends come on.
  This operation will set up the aircraft air conditioning system to supply maximum airflow for engine start.
  The pneumatic power will be supplied from either the **APU** (depending on the altitude) or the other engine (crossbleed valve open).
- Press the **ENG START** pushbutton switch. The **ARM** legend goes off. This opens the start valve and provides pneumatic power to the starter which motors the engine core shaft. The **OPEN** legend comes on as soon as the valve leaves the fully closed position.

If **EGT** is above 180°C, motor the engine to reduce **EGT** below 180°C.
When **N2** reaches 15 % minimum, move the **HP** fuel shut off valve control lever to **ON** position (if possible, **N2** shall be above 20 %). **N2** will increase and **EGT** will rise.

CAUTION : CLOSELY MONITOR N2 AND EGT

- **IF EGT EXCEEDS THE STARTING LIMIT OF 650°C, THE START SEQUENCE MUST BE ABORTED IMMEDIATELY BY RETURNING THE HP FUEL SHUT OFF VALVE CONTROL LEVER TO OFF POSITION.**
- **A SLUGGISH N2 ACCELERATION IS AN INDICATION OF EITHER A HOT OR HUNG START ; IF EGT RISES RAPIDLY, THE START SEQUENCE MUST BE ABORTED IMMEDIATELY ; IF EGT INCREASES SLOWLY CHECK THAT IDLE IS OBTAINED 90 S. AFTER PLACING HP FUEL SHUT OFF VALVE CONTROL LEVER IN ON POSITION ; IF THIS CONDITION IS NOT FULFILLED, THE START SEQUENCE WILL BE ABORTED IMMEDIATELY.**
- **CHECK THAT A POSITIVE INDICATION OF OIL PRESSURE IS OBTAINED AFTER N2 ACCELERATION.**

When **N2** reaches 45 %, the start valve will automatically close, the **OPEN** legend will go off.
Return the **ENG IGNITION** selector switch to the **OFF** position restoring the air conditioning system and **APU** to pre-start conditions.
Return **ENG IGNITION** selector switch to the **OFF** position.

CONTROL AND INDICATING - DEACTIVATION/REACTIVATION

Ref. : MMEL Sect. 1-80, Item 1 (Start valve "OPEN" lt.)

1. Deactivation

A. Reason for the Job
Failure of START 1(2) valve pushbutton switch system

B. Equipment and Materials

ITEM	DESIGNATION
(1)	Warning Notice

C. Procedure
WARNING : AVOID DANGER AREAS IN FRONT AND REAR OF ENGINE DURING GROUND RUNNING OPERATIONS (REF. 71-00-00, P. BLOCK 201).
WARNING : EAR AND EYE PROTECTIVE EQUIPMENT MUST BE WORN BY PERSONNEL WORKING NEAR AIRCRAFT WHILE ENGINES ARE RUNNING.
(1)Access to the manual override is via a hole on RH reverser cowl at 5 o'clock (rear view, looking forward).
(2)After engine start sequence, check manually by means of a 3/8 drive square that start valve is in closed position (turn clockwise).
NOTE : Access to manual 3/8 drive socket is gained by removing plug from
R manual start hole.

D. Close-Up
Install a warning notice in flight compartment indicating that START 1(2) pushbutton switch system is inoperative.

2. Reactivation

A. Troubleshoot the system as per TSM (Ref. 71-04).

B. Remove the warning notice.

C. Install plug.
NOTE : The plug can be installed when right thrust reverser cowl door is open or through the IDG servicing access door when thrust reverser cowl door is closed.

PNEUMATIC STARTER AND VALVE SYSTEM - DESCRIPTION AND OPERATION

1. Pneumatic Starter (Ref. Fig. 001, 002)
The starter is designed to provide, when supplied with a corrected airflow of 94 lb/mn ± 3 lb/mn, a high enough torque to the engine core shaft in order to achieve a starting time (from start valve opening up to N2 idle) of less than 45 s. This starter shall also be able, in case of start valve failure, to withstand an engine speed higher than 45 % (4455 RPM).
Furthermore, in case of starter failure, all debris will remain in the starter housing.
The starter is engaged to the engine accessory gearbox by means of a quad clamp.
This starter consists of :

A. A turbine driven by the supplied air (corrected airflow of 94 lb/min. With an air temperature of 425°F (218°C), the actual free running speed of the rotor, for nominal flow, is 90667 RPM. This rotor is supported on two ball bearings with carbon seal to prevents oil leakage.
(1)The stator of the turbine is an integral part of the starter turbine inlet housing. This housing is designed to absorb the kinetic energy of a burst rotor.
(2)This housing provides also the air exhaust passages into the nacelle, the exhaust air pressure is 0.5 psi above ambient for all altitudes.

B. A gear train, with a gear ratio of 14.08/1, all gears and bearings are splash lubricated from the transmission housing oil sump.
A magnetic drain plug situated at the bottom of the transmission housing allows the detection of failure.

C. The engaging disengaging mechanism is a pawl and ratchet type clutch.
The ratchet is attached to the output of the gear train and has 18 teeth. It is the input side of the clutch and rotates only during the starting cycle.
The output side of the clutch consists of a pawl carrier which supports three equally spaced pawls, each of which is spring loaded to control disengaging and reengaging speeds. The pawls carrier rotates with the engine core shaft. At N2 ≥ 45 %, the spring loaded pawls are disengaged from the ratchet by centrifugal force. During engine operation, the pawl carrier rotates with the engine with pawls disengaged.
During engine run down, the centrifugal force of the pawls drops and the spring forces the pawls into contact with the ratchet ready for the next engine start sequence.

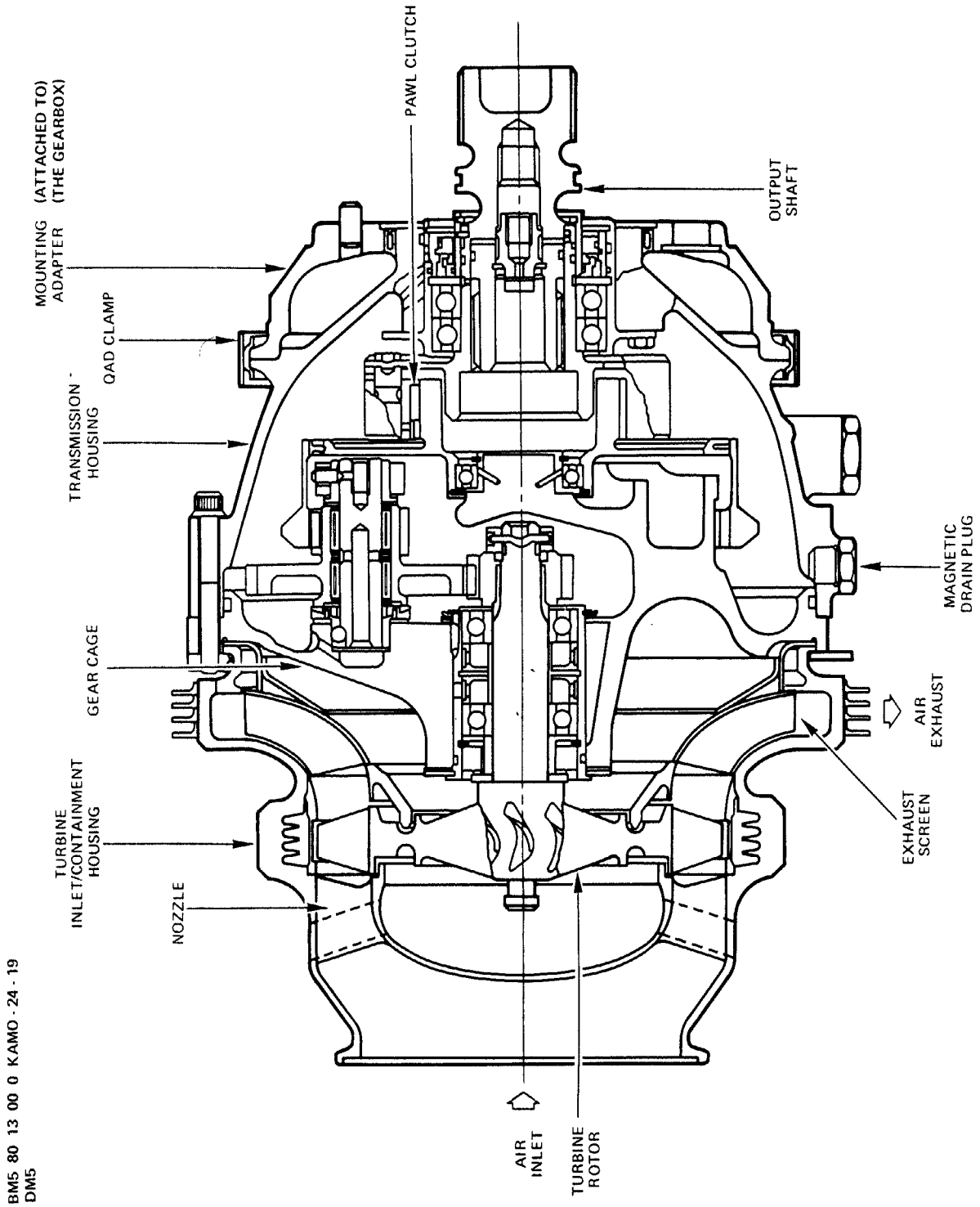
D. An output shaft
This shaft transmits torque to the engine. It can sustain a torque load of 2415 lb/ft (3275 NM) without failure or deformation.
The output shaft seal is a magnetic type which provides minimum heat generation.
The free running speed of the output shaft is 6443 RPM (N2 : 77.4 %)
NOTE : In case of failure, the rotor is provided with a stress fuse in the shaft, this stress fuse will be activated in a speed range

of 120 600 to 135 000 RPM (1.33 to 1.49 times maximum free running speed). This stress fuse will break and stop the starter rotor in a predetermined area, where the containment can be assured.

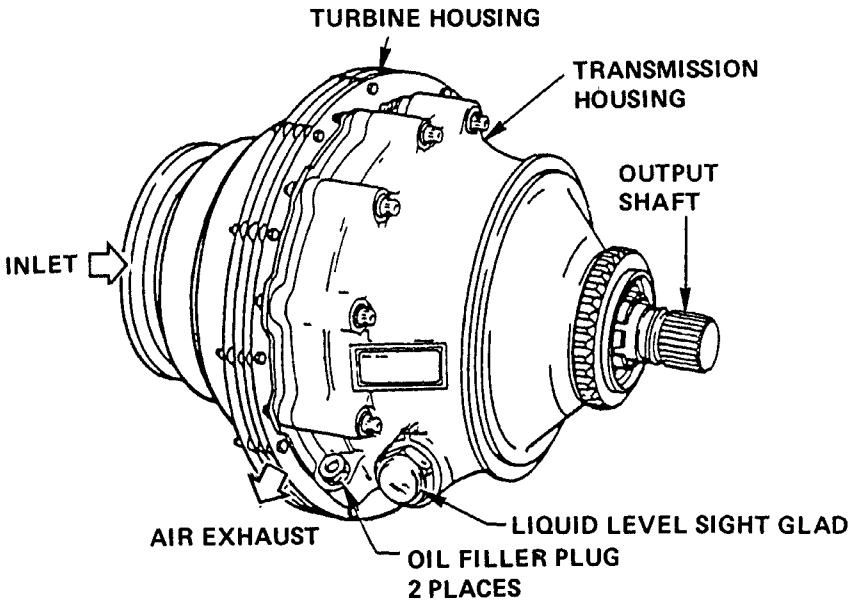
E. Lubrication system :
The starter gears and bearings are splash - lubricated by an intergral oil system.
An oil filler (with overflow) and drain ports are provided, as well as a sightgage.
The Drain plug assy includes a magnetic element, that is removed from the drain plug without requiring draining the oil.

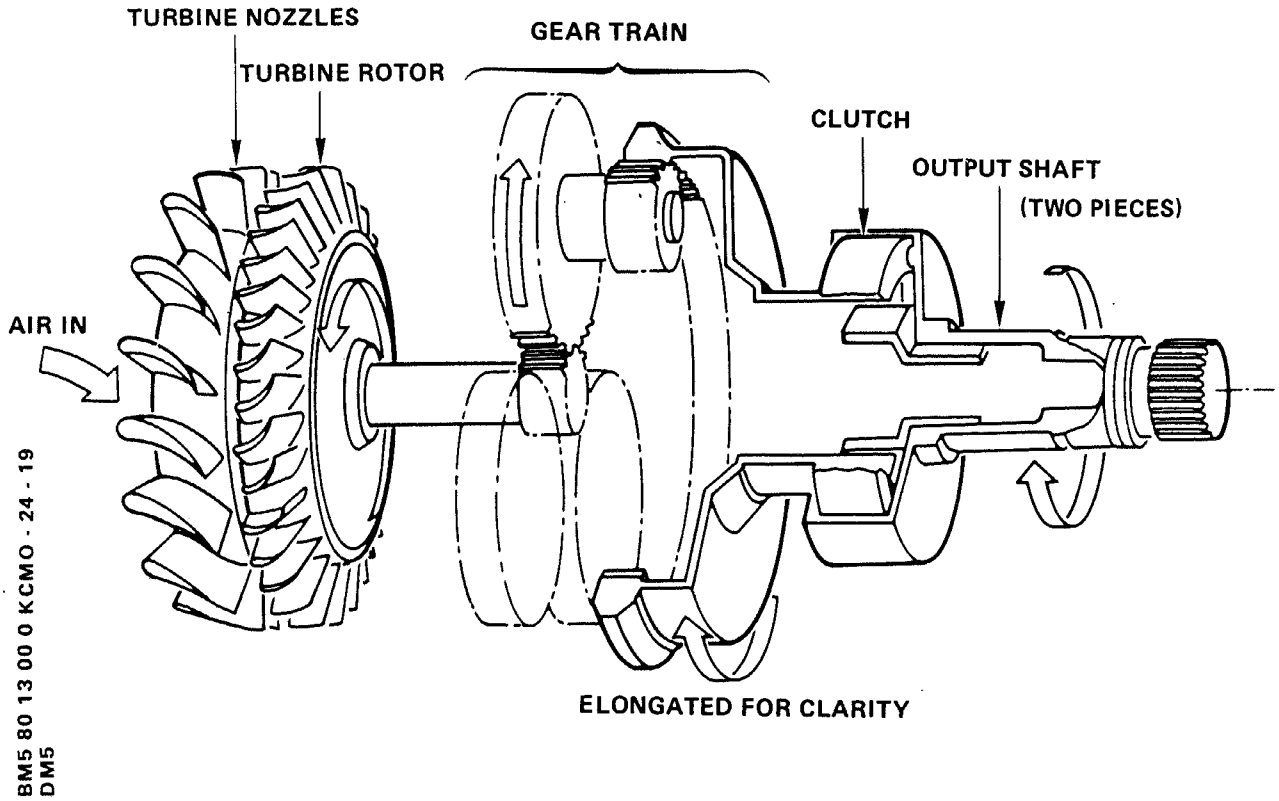
2. Starter Shutoff Valve (Ref. Fig. 003)
The starter shut off valve controls the pneumatic supply to the starter. It is a 4 in flap type valve, electrically controlled and pneumatically actuated. A solenoid operated pilot valve is utilized to admit upstream air to the actuator. When the START pushbutton switch on ENG START panel is pressed the solenoid is energized and allows pressurised air to be supplied to the actuator, which moves the flap to the open position. As soon as the flap leaves the closed position a switch is activated, which causes the Blue OPEN legend to come on.
At N2 = 45 %, the electrical supply to the solenoid is cut off and the pilot valve is ventilated, allowing the flap to come back to the closed position. When this condition is fulfilled, the OPEN legend goes off.
In case of failure of the valve, a manual override device may be operated by the personnel on ground to enable engine start. Its access is possible through an access door situated on the left hand thrust reverser (appoximately at 7 O'clock). It must be held ON until N2 reaches 45 %.
The valve is clamped to the aft end of the starter and connected to the starter air supply duct.

3. Pneumatic Starter Air Supply Duct
The engine pneumatic starter air supply duct carries pressurized air from the pneumatic manifold near the top left of the engine to the starter shutoff valve. the duct consists of three segments joined with couplings. The stater lower air supply duct has a pneumatic coupling used for ground operation of the thrust reverser. The duct is attached to the engine by support links.



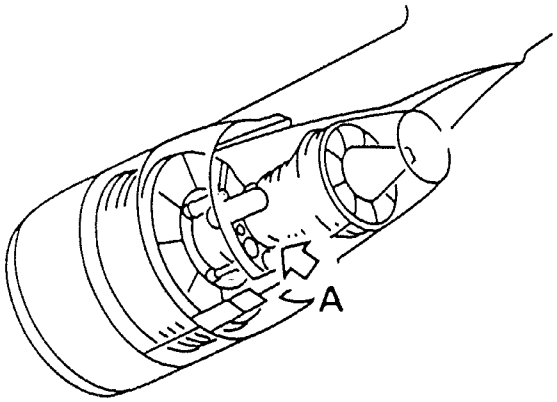
Air Starter Cross Section
Figure 001

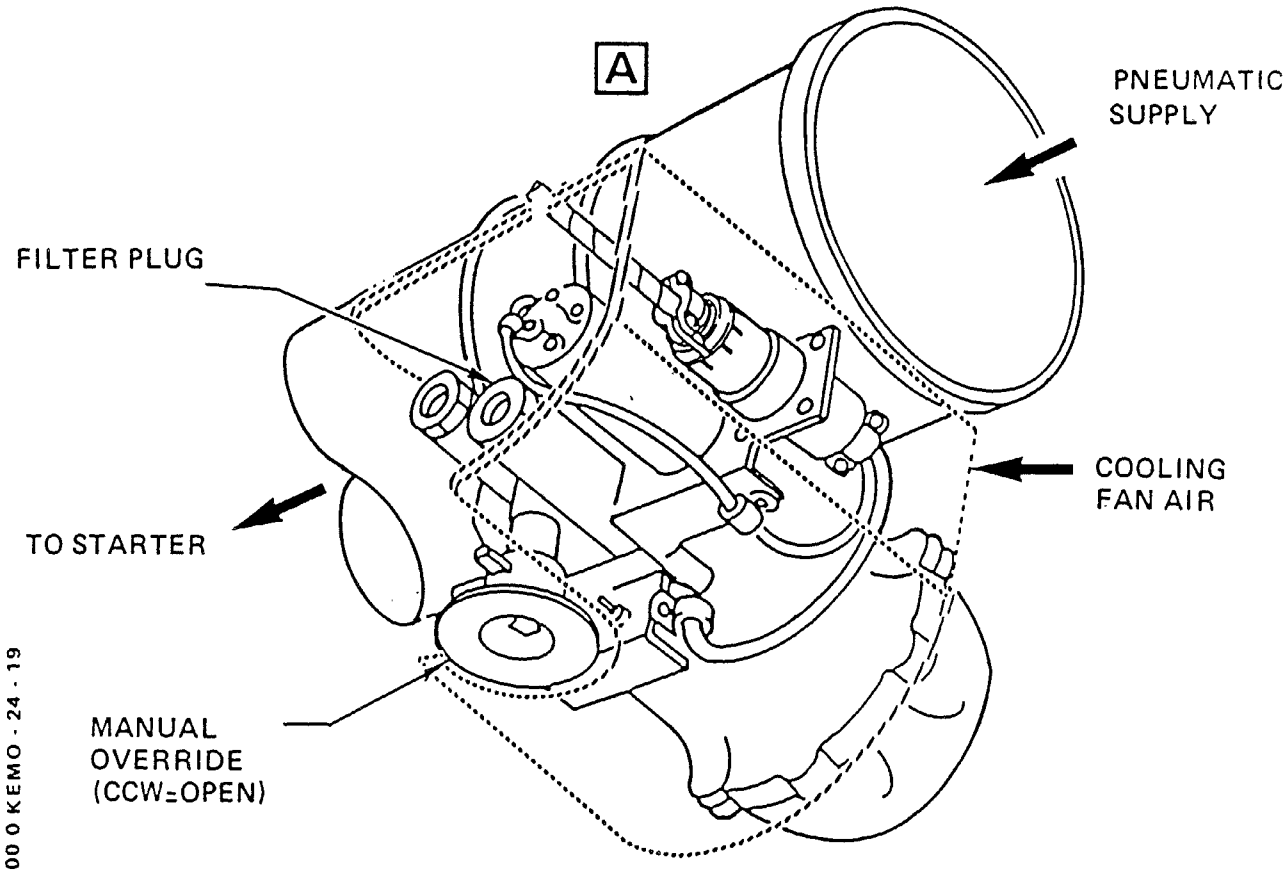




BM5 80 13 00 0 KCMO · 24 · 19
DM5

Air Starter Operating Principle
Figure 002





Starter Shutoff Valve
Figure 003

PNEUMATIC STARTER AND VALVE SYSTEM - DEACTIVATION/REACTIVATION

Ref. : MMEL Sect. 1-80, Item 2 (Starter valve system)

R 1. Manual Engine Start and Check of the Correct Closed Position of the
R Pneumatic Starter Valve

R CAUTION : THE FOLLOWING PROCEDURE MUST BE PERFORMED BEFORE EVERY FLIGHT
R UNDER THIS MMEL ITEM. IF YOU DON'T, THAT COULD LEAD TO AN IN-FLIGHT
R SHUT DOWN.

A. Reason for the Job
Failure of the pneumatic starter and valve system.

B. Equipment and Materials

ITEM	DESIGNATION
A.	Warning Notice
B.	3/8 in. (9.52 mm) Drive Square
Referenced Procedures	
- 71-00-00, P. Block 201	Power Plant
- 71-00-00, P. Block 501	Power Plant

C. Procedure
WARNING : WHEN WALKING AWAY FROM THE ENGINE AFTER MANUAL OPERATION OF THE START VALVE, BE CAREFUL TO KEEP AWAY FROM DANGEROUS ZONES. (REF. 71-00-00, P. BLOCK 201).
WARNING : EAR AND EYE PROTECTIVE EQUIPMENT MUST BE WORN BY PERSONNEL WORKING NEAR AIRCRAFT WHILE ENGINES ARE RUNNING.

(1)Job set-up
(a)Establish communications between ground crew and flight compartment.
NOTE : There is possibility to have an intercommunication between ground crew and flight compartment during engine motoring by using the appropriate phone jack.
R (b)On left reverser cowl at 5 o'clock position, push plug to gain access
R to manual override (Ref. Fig. 901).
R (2)Starting procedure and pneumatic starter valve manual opening
R (Ref. Fig. 902).
(a)In flight compartment prepare, service and start engine (Ref. 71-00-00, P. Block 201) and press START 1(2) pushbutton switch on ENG START section of panel 429VU.
(b)Tell ground crew to open valve.
CAUTION : WHEN EXERCISING START VALVE, MANUALLY MAINTAIN A FIRM AND POSITIVE OPENING ACTION SO AS TO PREVENT CLOSING VALVE INADVERTENTLY (SPRING LOADED) AND TO PREVENT ANY POSSIBILITY OF STARTER CRASH REENGAGEMENT.
(c)On ground, by means of a 3/8 drive square, rotate valve (counterclockwise) to open and maintain it in open position.
(d)On ENG START section of panel 429VU, check that OPEN legend of START

1(2) pushbutton switch comes on blue.

(e)Starter is engaged, continue start sequence (Ref. 71-00-00, P. Block 201).

(f)When N2 has reached 45 %, tell ground crew to close valve.

(g)On ground, release manual override to close valve (spring-loaded).

R Check that 3/8 drive square rotates clockwise to retrieve the closed
R position.

(h)On ENG START section of panel 429VU, check that OPEN legend of START 1 (2) pushbutton switch goes off.

(i)Starter is disengaged, continue start sequence (Ref. 71-00-00, P. Block 201).

(3)Close-up

(a)Display a warning notice in flight compartment indicating that engine 1 (2) start valve system is inoperative.

2. Reactivation

A. Equipment and Materials

ITEM	DESIGNATION
Referenced Procedures :	
- 71-00-00, P. Block 201	Power Plant

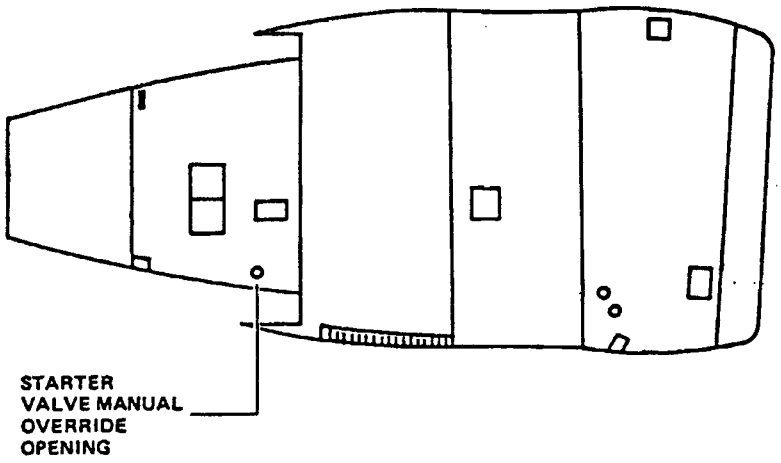
B. Procedure

(1)Trouble shoot starting system (Ref. TSM 71-04).

(2)Open IDG servicing access door and install manual override hole plug.

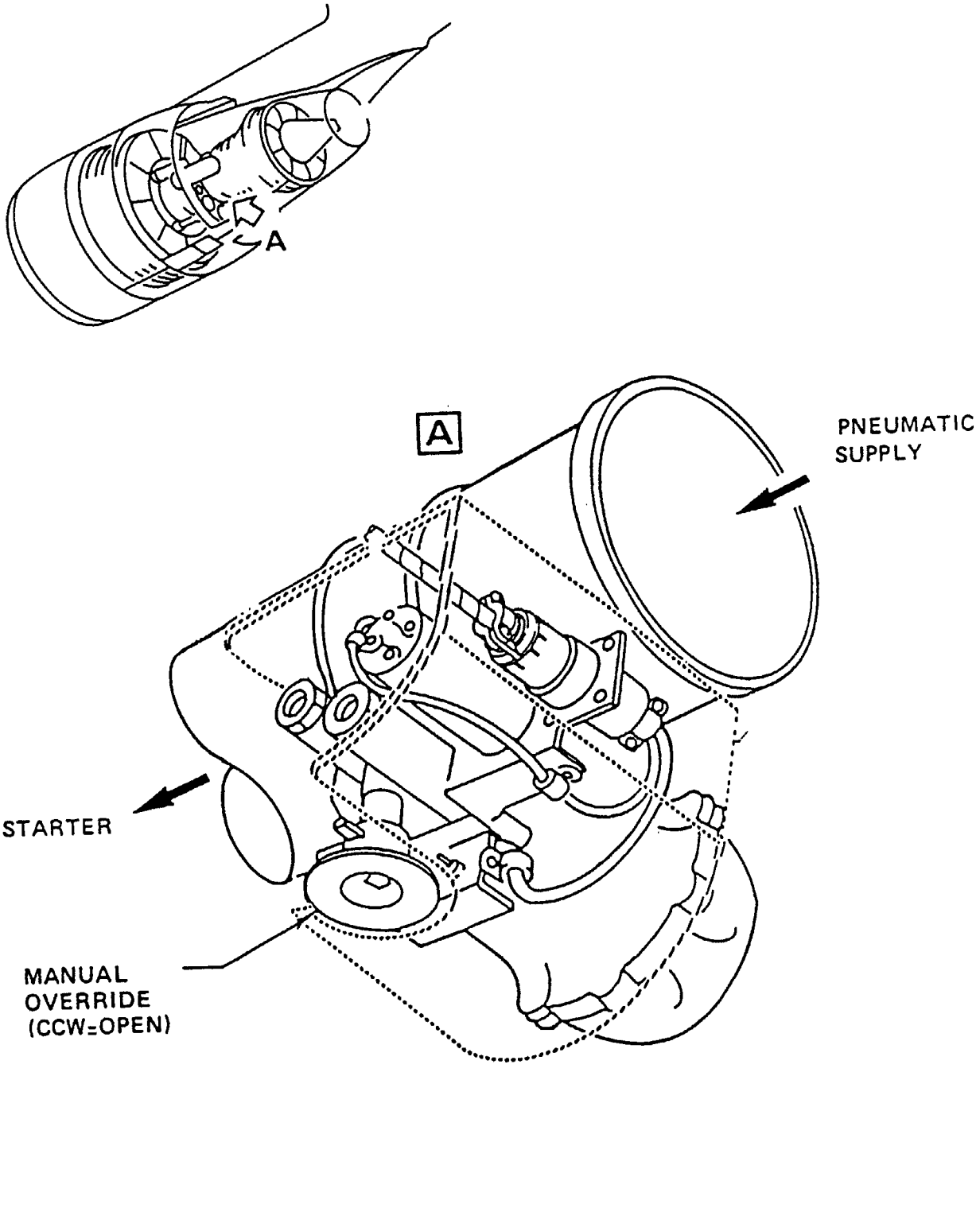
(3)Remove warning notice.

(4)Start and shut down engine (Ref. 71-00-00, P. Block 201).



BM5 80 13 00 9 KAM0 00

Access to Starter Valve Manual Override
Figure 901



Starter Valve
Figure 902

PNEUMATIC STARTER ASSEMBLY - REMOVAL/INSTALLATION

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Container
C.	Protective Covers
D.	Packing
E.	Pressure Seals
F.	Torque Wrench
G.	Corrosion Resistant Steel Lockwire (Ref. 70-00-00)
H. Material No.P03-001	Oils (Ref. 70-00-00)
I. Material No. P06-052	Lubricants (Ref. 70-00-00)
J. Material No. P06-059	Lubricants (Ref. 70-00-00)
Referenced Procedures	
- 12-13-80, P. Block 1	Replenishing - Starting System
- 71-00-00, P. Block 501	Power Plant - General
- 71-13-00, P. Block 301	Cowl Doors

2. Procedure

A. Job Set-Up

(1)Open, safety and tag the appropriate circuit breakers and open the fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).

B. Removal (Pressure Fill Configuration) (Ref. Fig. 401)

(1)Place oil container under engine pneumatic starter drain plug.

WARNING : WHEN PERFORMING MAINTENANCE ON AN ENGINE THAT HAS BEEN RECENTLY USED OR RUN, EXERCISE CAUTION WHEN REMOVING DRAIN PLUGS AND CHIP COLLECTORS AS HOT OIL CAN CAUSE SERIOUS INJURY TO EYES OR SEVERE BURNS TO PERSONNEL.

(2)Remove chip collector and drain plug, and allow oil to drain.

(3)Place oil container under pneumatic starter Quich-Attach-Detach (QAD) adapter drain plug.

(4)Remove pneumatic starter QAD adapter drain plug and packing and allow any oil present to drain. Discard packing.

NOTE : Oil in the starter QAD adapter indicates a defective starter output shaft packing or accessory gearbox starter drive oil seal.

(5)On starter lower, forward duct assembly loosen V-ring clamps on each end and remove duct.

(6)Discard pressure seals.

CAUTION : ADEQUATELY SUPPORT STARTER PRIOR TO REMOVING QUICK-ATTACH-DETACH (QAD) ADAPTER RING CLAMP THAT FASTENS STARTER TO QAD ADAPTER MOUNTED ON ACCESSORY GEAR CASE OR SEVERE DAMAGE TO EQUIPMENT CAN OCCUR.

R (7)Remove QAD adapter ring clamp, draw starter from accessory gear case, and

remove.
(8)Discard packing from starter drive shaft.
(9)Place protective covers on starter QAD adapter, adapter drain port, starter, air duct and starter shutoff valve.

C. Installation (Pressure Fill Configuration) (Ref. Fig. 401)
(1)Remove all protective covers.
(2)Install pressure fill overflow adapter as follows :
(a)Position jamnut on adapter fingertight.
(b)Lubricate threads of adapter with Material No.P03-001.
(c)Lubricate packing with Material No.P03-001, and position on threads of adapter.
(d)Install adapter in starter overflow pressure fill port and align to specified direction.
(e)TORQUE jamnut to between 220 and 225 lbf. in. (0.24 and 0.25 m.daN).
(f)Install dust cap on adapter.

R
(3)Install starter on accessory gearbox case as follows :
CAUTION : TO PREVENT INDUCING LOADS INTO THE DRIVE PAD CARBON SEAL, CARE SHOULD BE TAKEN TO PROPERLY ALIGN AND SUPPORT THE COMPONENT DURING INSTALLATION.
(a)Lubricate starter drive gear packing with Material No.P03-001, and position on starter output drive shaft.
CAUTION : BEFORE YOU APPLY FLUORINATED GREASE LUBRICANT (MATERIAL No.P06-059) TO THE STARTER DRIVE COUPLING, MAKE SURE THE STARTER DRIVE COUPLING SPLINES AND STARTER DRIVE GEARSHAFT SPLINES ARE CLEAN AND NOT DAMAGED. APPLY FLUORINATED GREASE LUBRICANT (MATERIAL No.P06-059) TO THE STARTER DRIVE COUPLING SPLINES TO REDUCE WEAR AND INCREASE SERVICE LIFE OF THE PARTS.
(b)Lubricate output drive shaft and accessory gearbox splines with Fluorinated Grease Lubricant (Material No.P06-059), Silicone Lubricant (Material No. P06-052) or Engine Oil (Material No. P03-001).
NOTE : Fluorinated Grease Lubricant (Material No. P06-059), the preferred material, protects against wear.
(c)Center starter on QAD adapter and move it forward into accessory gearbox case until gears and splines mate smoothly, and alignment keys match.
(d)Fasten QAD adapter ring clamp sufficiently to hold weight of starter.
(e)Tap around perimeter of QAD adapter clamp with brass drift and TORQUE to between 60 and 65 lbf. in. (0.68 and 0.73 m.daN).
(f)Re-tap and re-torque to between 60 and 65 lbf. in. (0.68 and 0.73 m.daN). Continue this procedure until no torque drop is noted.
(4)Install pressure fill adapter as follows :
(a)Install jamnut fingertight on adapter.
(b)Lubricate packing with Material No.P03-001, and position on adapter.
(c)Lubricate adapter threads with Material No.P03-001.
(d)Install adapter in pressure fill port and TORQUE jamnut to between 70 and 80 lbf. in. (0.79 and 0.90 m.daN).
(e)Install dust cap on pressure fill adapter.
(5)Install chip collector and drain plug as follows :

(a)Lubricate threads of both halves of chip collector and drain plug with Material No.P03-001.
(b)Lubricate inner plug packing and position on inner plug.
(c)Install inner plug in outer plug.
(d)Lubricate outer plug packing and position on outer plug.
(e)Install complete chip collector and drain plug in drain port at bottom of starter.
(f)TORQUE 0.750 in. (19.050 mm) plug to between 10 and 25 lbf. in. (0.11 and 0.28 m.daN). TORQUE 0.560 in. (14.224 mm) plug to between 5 and 15 lbf. in. (0.06 and 0.17 m.daN).
(g)Lockwire plug to starter housing.

(6)Install sight gauge as follows :
(a)Lubricate packing with Material No.P03-001, and position on sight gauge.
(b)Lubricate threads of sight gauge with Material No.P03-001.
(c)Install sight gauge in starter housing and TORQUE to between 45 and 60 lbf. in. (0.51 and 0.68 m.daN).

(7)Install right and left non-pressure oil filler plugs as follows :
(a)Lubricate threads of plugs with Material No.P03-001.
(b)Lubricate packings with Material No.P03-001, and position on plugs.
(c)Install plugs in starter housing and TORQUE to between 20 and 35 lbf. in. (0.23 and 0.40 m.daN).

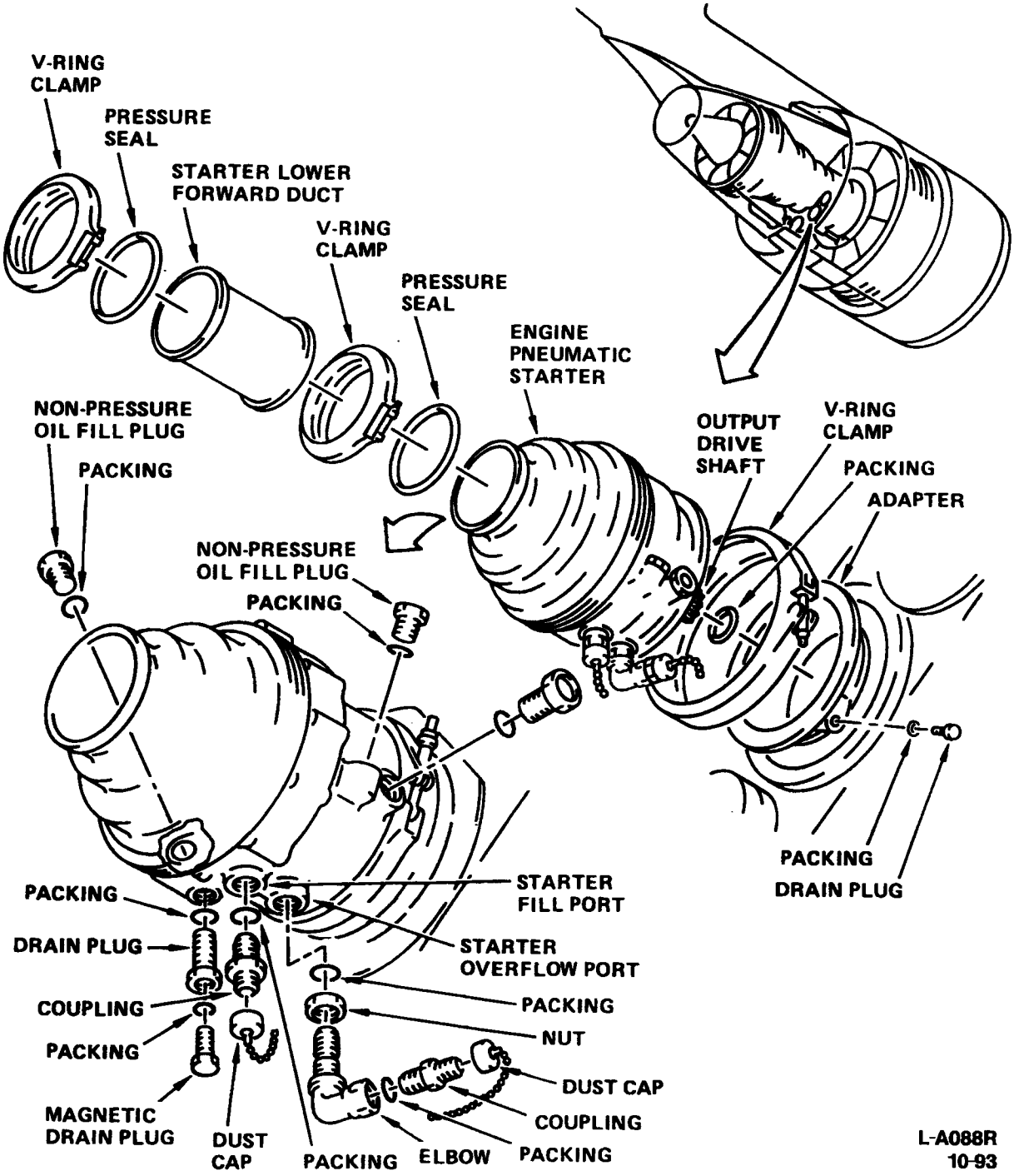
(8)Install starter lower, forward duct assembly between starter and shutoff valve as follows :
(a)Install pressure seals on mating flanges at input of starter and input of lower, forward duct assembly.
(b)Position duct so that alignment keys on starter input and duct output are mated.
(c)Install V-ring clamp on starter end of duct and fasten sufficiently to hold duct in position.
(d)Make certain that alignment keys on input of duct and output of shutoff valve are mated and install V-ring clamp fingertight.
(e)Tap lightly around exposed perimeter of both V-ring clamps and TORQUE each to 120 lbf. in. (1.36 m.daN).
(f)Re-tap around exposed perimeter of V-ring with brass drift and re-torque to 120 lbf. in. (1.36 m.daN).
(g)Continue this procedure until no torque drop is noted.

(9)Lubricate packing with Material No.P03-001 and install on pneumatic starter QAD adapter drain plug.

(10)Install drain plug in QAD adapter drain port. TORQUE drain plug to between 80 and 90 lbf. in. (10.90 and 1.01 m.daN).

B. Removal (Non-Pressure Fill Configuration) (Ref. Fig. 402)

(1)Place oil container under engine pneumatic starter drain plug.
WARNING : WHEN PERFORMING MAINTENANCE ON AN ENGINE THAT HAS BEEN RECENTLY USED OR RUN, EXERCISE CAUTION WHEN REMOVING DRAIN PLUGS AND CHIP COLLECTORS AS HOT OIL CAN CAUSE SERIOUS INJURY TO EYES OR SEVERE BURNS TO PERSONNEL.
(2)Remove chip collector and drain plug, and allow oil to drain.
(3)Place oil container under pneumatic starter Quich-Attach-Detach (QAD) adapter drain plug.



Pneumatic Starter Assembly (Pressure Fill Configuration)
Figure 401

(4)Remove pneumatic starter QAD adapter drain plug and packing and allow any oil present to drain. Discard packing.
NOTE : Oil in the starter QAD adapter indicates a defective starter output shaft packing or accessory gearbox starter drive oil seal.
(5)On starter lower, forward duct assembly loosen V-ring clamps on each end and remove duct.
(6)Discard pressure seals.
CAUTION : ADEQUATELY SUPPORT STARTER PRIOR TO REMOVING QUICK-ATTACH-DETACH (QAD) ADAPTER RING CLAMP THAT FASTENS STARTER TO QAD ADAPTER MOUNTED ON ACCESSORY GEAR CASE OR SEVERE DAMAGE TO EQUIPMENT CAN OCCUR.

R

(7)Remove QAD adapter ring clamp, draw starter from accessory gear case, and remove.
(8)Discard packing from starter drive shaft.
(9)Place protective covers on starter QAD adapter, adapter drain port, starter, air duct and starter shutoff valve.

C. Installation (Non-Pressure Fill Configuration) (Ref. Fig. 402)
(1)Remove all protective covers.

R

(2)Install starter on accessory gearbox case as follows :
CAUTION : TO PREVENT INDUCING LOADS INTO THE DRIVE PAD CARBON SEAL, CARE SHOULD BE TAKEN TO PROPERLY ALIGN AND SUPPORT THE COMPONENT DURING INSTALLATION.
(a)Lubricate starter drive gear packing with Material No.P03-001, and position on starter output drive shaft.
CAUTION : BEFORE YOU APPLY FLUORINATED GREASE LUBRICANT (MATERIAL No.P06-059) TO THE STARTER DRIVE COUPLING, MAKE SURE THE STARTER DRIVE COUPLING SPLINES AND STARTER DRIVE GEARSHAFT SPLINES ARE CLEAN AND NOT DAMAGED. APPLY FLUORINATED GREASE LUBRICANT (MATERIAL No.P06-059) TO THE STARTER DRIVE COUPLING SPLINES TO REDUCE WEAR AND INCREASE SERVICE LIFE OF THE PARTS.
(b)Lubricate output drive shaft and accessory gearbox splines with Fluorinated Grease Lubricant (Material No.P06-059), Silicone Lubricant (Mat No. P06-052) or Engine Oil (Material No. P03-001).
NOTE : Fluorinated Grease Lubricant (Material No. P06-059), the preferred material, protects against wear.
(c)Center starter on QAD adapter and move it forward into accessory gearbox case until gears and splines mate smoothly, and alignment keys match.
(d)Fasten QAD adapter ring clamp sufficiently to hold weight of starter.
(e)Tap around perimeter of QAD adapter clamp with brass drift and TORQUE to between 60 and 65 lbf. in. (0.68 and 0.73 m.daN).
(f)Re-tap and re-torque to between 60 and 65 lbf. in. (0.68 and 0.73 m.daN). Continue this procedure until no torque drop is noted.
(3)Install chip collector and drain plug as follows :
(a)Lubricate threads of both halves of chip collector and drain plug with Material No.P03-001.

(b)Lubricate inner plug packing and position on inner plug.
(c)Install inner plug in outer plug.
(d)Lubricate outer plug packing and position on outer plug.
(e)Install complete chip collector and drain plug in drain port at bottom of starter.
(f)TORQUE 0.750 in. (19.050 mm) plug to between 10 and 25 lbf. in. (0.11 and 0.28 m.daN). TORQUE 0.560 in. (14.224 mm) plug to between 5 and 15 lbf. in. (0.06 and 0.17 m.daN).
(g)Lockwire plug to starter housing.

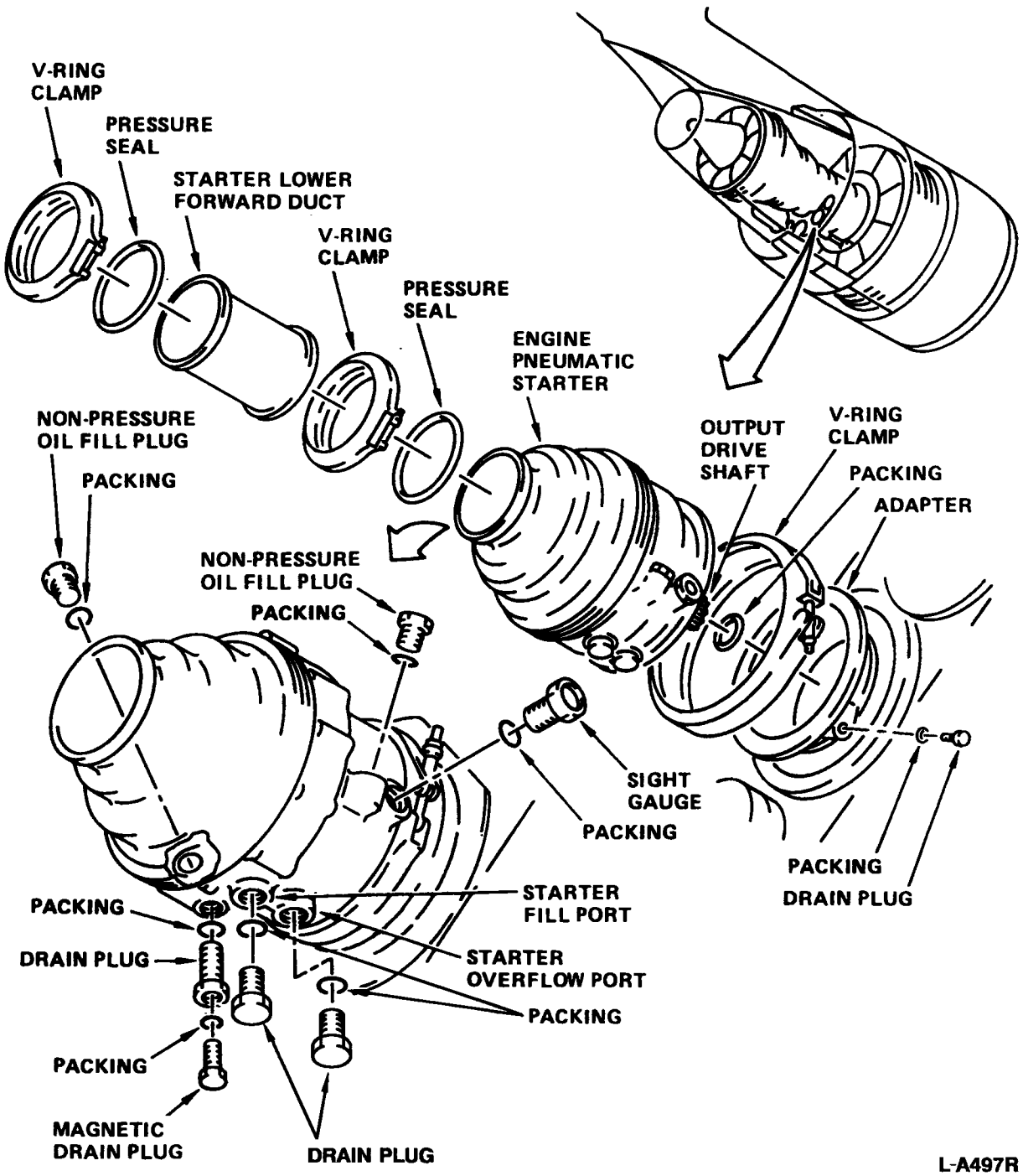
(4)Install sight gauge as follows :
(a)Lubricate packing with Material No.P03-001, and position on sight gauge.
(b)Lubricate threads of sight gauge with Material No.P03-001.
(c)Install sight gauge in starter housing and TORQUE to between 45 and 60 lbf. in. (0.51 and 0.68 m.daN).

(5)Install right and left non-pressure oil filler plugs as follows :
(a)Lubricate threads of plugs with Material No.P03-001.
(b)Lubricate packings with Material No.P03-001, and position on plugs.
(c)Install plugs in starter housing and TORQUE to between 20 and 35 lbf. in. (0.23 and 0.40 m.daN).

(6)Install starter lower, forward duct assembly between starter and shutoff valve as follows :
(a)Install pressure seals on mating flanges at input of starter and input of lower, forward duct assembly.
(b)Position duct so that alignment keys on starter input and duct output are mated.
(c)Install V-ring clamp on starter end of duct and fasten sufficiently to hold duct in position.
(d)Make certain that alignment keys on input of duct and output of shutoff valve are mated and install V-ring clamp fingertight.
(e)Tap lightly around exposed perimeter of both V-ring clamps and TORQUE each to 120 lbf. in. (1.36 m.daN).
(f)Re-tap around exposed perimeter of V-ring with brass drift and re-torque to 120 lbf. in. (1.36 m.daN).
(g)Continue this procedure until no torque drop is noted.

(7)Lubricate packing with Material No.P03-001 and install on pneumatic starter QAD adapter drain plug.
(8)Install drain plug in QAD adapter drain port. TORQUE drain plug to between 80 and 90 lbf. in. (10.90 and 1.01 m.daN).

D. Close-Up and Test
(1)Service starter with engine oil (Ref. 12-13-80, P. Block 1).
(2)Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(3)Remove safety clip and tag and close circuit breaker 1KG.
(4)Dry motor engine (Ref. 71-00-00, P. Block 501) and check starter for proper operation and evidence for leakage.
(5)Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



BM5 80 13 01 4 KCMO 00

Pneumatic Starter Assembly
(Non-Pressure Fill Configuration)
Figure 402

PNEUMATIC STARTER ASSY - INSPECTION/CHECK

1. Equipment and Materials

ITEM	DESIGNATION
A. Material No.P03-001	Oils (Ref. 70-00-00)
B.	Circuit Breaker Safety Clips
C.	Packings
D.	Corrosion Resistant Steel Lockwire (MS20995C20) (Ref. 70-00-00)
E.	Torque Wrench
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 12-13-80, P. Block 1	Starting System
- 80-13-01, P. Block 401	Pneumatic Starter Assy.

2. Procedure

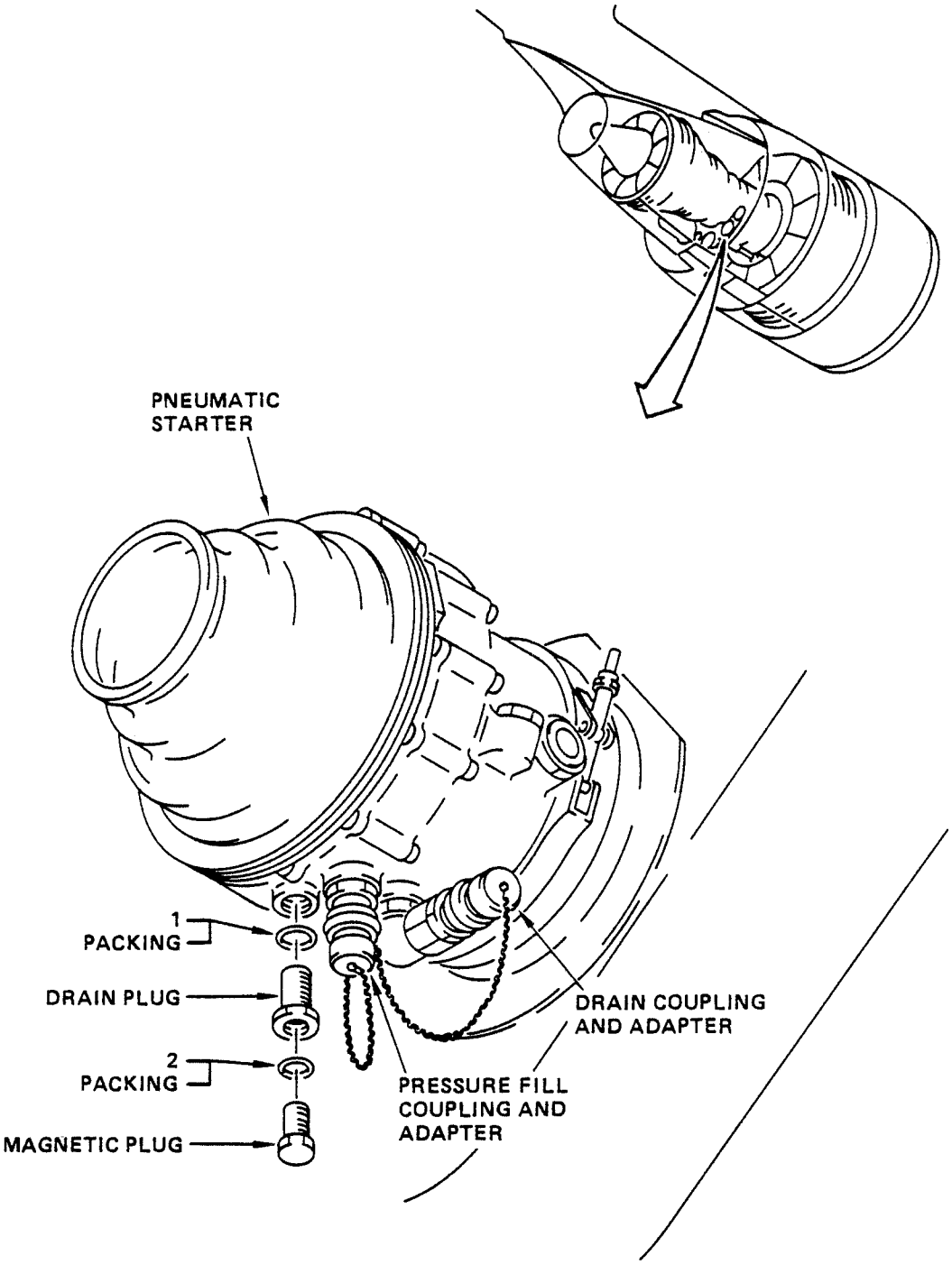
A. Job Set-Up
(1)Open, safety and tag circuit breakers for the appropriate engine and open fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).

R B. Inspection/Check Procedure (Pressure Fill Configuration)
R (Ref. Fig. 601, 602)
R (1)Remove magnetic chip collector from starter and check plug for presence of chips and/or slivers large enough to bridge the magnet gap.
NOTE : If any slivers or chips larger than 0.10 in. (2.54 mm) are found, replace starter.
NOTE : The drain plug has a special two part base which allows the inner
R member containing the chip collector to be unscrewed without loosing oil. A spring loaded seal closes the opening as the
R chip collector is withdrawn.
(2)Lubricate a new packing (2) with Material No.P03-001 and position on the
R magnetic drain plug. Install plug in the starter, TORQUE
R plug to between 5 and 10 lbf. in (0.056 and 0.113 m.daN) and safety to transmission housing using 0.020 in. (0.5 mm) corrosion resistant steel lockwire.
(3)Examine exterior of starter for evidence of oil leakage.
WARNING : WHEN PERFORMING MAINTENANCE ON AN ENGINE THAT HAS BEEN RECENTLY USED OR RUN, EXERCISE CAUTION WHEN DISCONNECTING OIL LINES OR DRAINING OIL, AS HOT OIL CAN CAUSE SERIOUS INJURY TO EYES OR SEVERE BURNS TO PERSONNEL.
R (a)If oil leakage is evident around starter oil drain plug, remove
R drain plug and allow starter oil to drain. Position new packing
R (1) on drain plug and TORQUE to between 10 and 25 lbf.in. (0.113 and 0.282 m.daN) and safety to transmission housing using 0.020 in. (0.5 mm) corrosion resistant steel lockwire. Fill starter with oil (Ref. 12-13-80, P. Block 301).
(b)If leakage is evident around pressure fill or drain coupling or adapters, check torque of bolts securing adapter and check torque of

couplings in adapters. If no looseness is found, replace appropriate packings (Ref. 80-13-01, P. Block 401).

R C. Inspection/Check Procedure (Non-Pressure Fill Configuration)
R (Ref. Fig. 603, 602)
R (1)Remove magnetic chip collector from starter and check plug for presence of chips and/or slivers large enough to bridge the magnet gap.
NOTE : If any slivers or chips larger than 0.10 in. (2.54 mm) are found, replace starter.
NOTE : The drain plug has a special two part base which allows the inner
R member containing the chip collector to be unscrewed without loosing oil. A spring loaded seal closes the opening as the
R chip collector is withdrawn.
(2)Lubricate a new packing (2) with Material No.P03-001 and position on the
R magnetic drain plug. Install plug in the starter, TORQUE
R plug to between 5 and 10 lbf. in (0.056 and 0.113 m.daN) and safety to transmission housing using 0.020 in. (0.5 mm) corrosion resistant steel lockwire.
(3)Examine exterior of starter for evidence of oil leakage.
WARNING : WHEN PERFORMING MAINTENANCE ON AN ENGINE THAT HAS BEEN RECENTLY USED OR RUN, EXERCISE CAUTION WHEN DISCONNECTING OIL LINES OR DRAINING OIL, AS HOT OIL CAN CAUSE SERIOUS INJURY TO EYES OR SEVERE BURNS TO PERSONNEL.
R (a)If oil leakage is evident around starter oil drain plug, remove
R drain plug and allow starter oil to drain. Position new packing
R (1) on drain plug and TORQUE to between 10 and 25 lbf.in. (0.113 and 0.282 m.daN) and safety to transmission housing using 0.020 in. (0.5 mm) corrosion resistant steel lockwire. Fill starter with oil (Ref. 12-13-80, P. Block 301).
(b)If leakage is evident around plugs, check torque of plugs. If no looseness is found, replace appropriate packings (Ref. 80-13-01, P. Block 401).

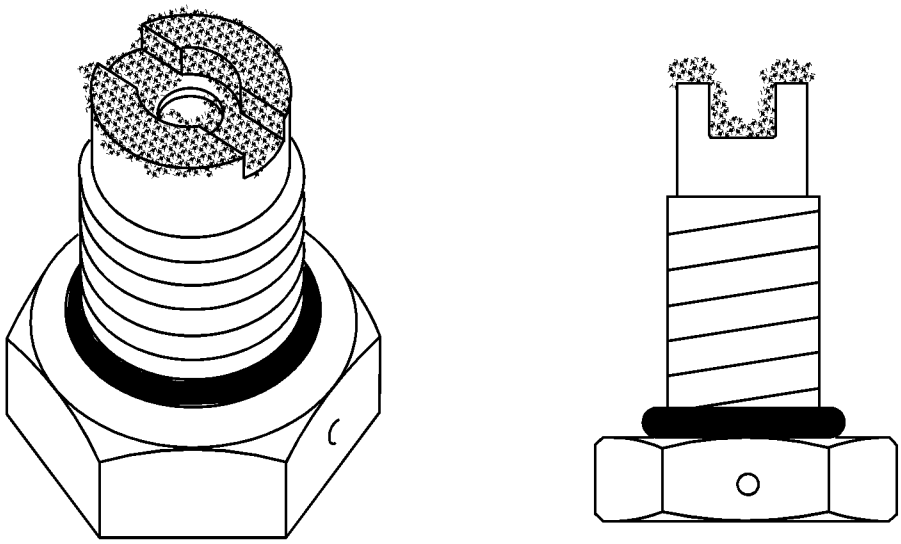
D. Close-Up
(1)Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(2)Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



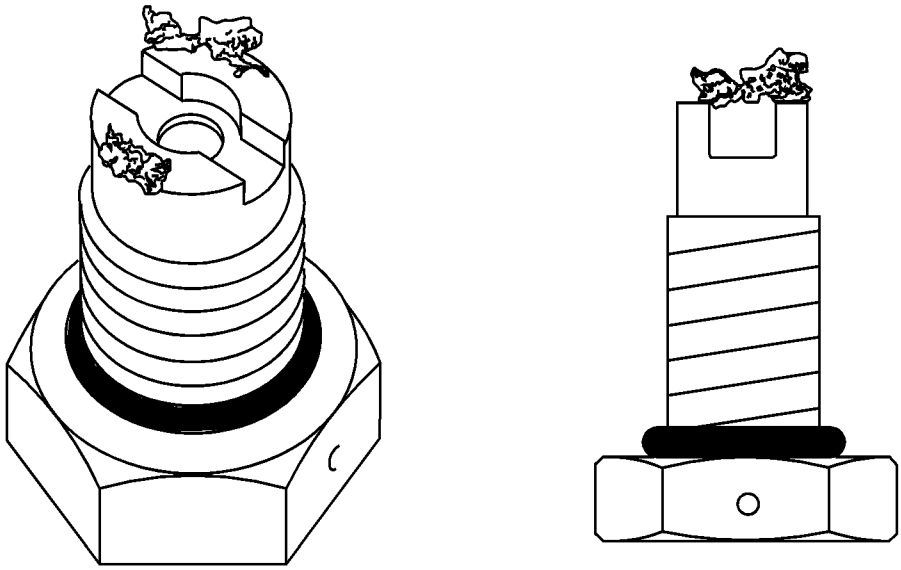
BM5 80 13 01 6 KAM0 01

Pneumatic Starter Assy (Pressure Fill Configuration)
Figure 601

R



SMALL PARTICLE DEBRIS



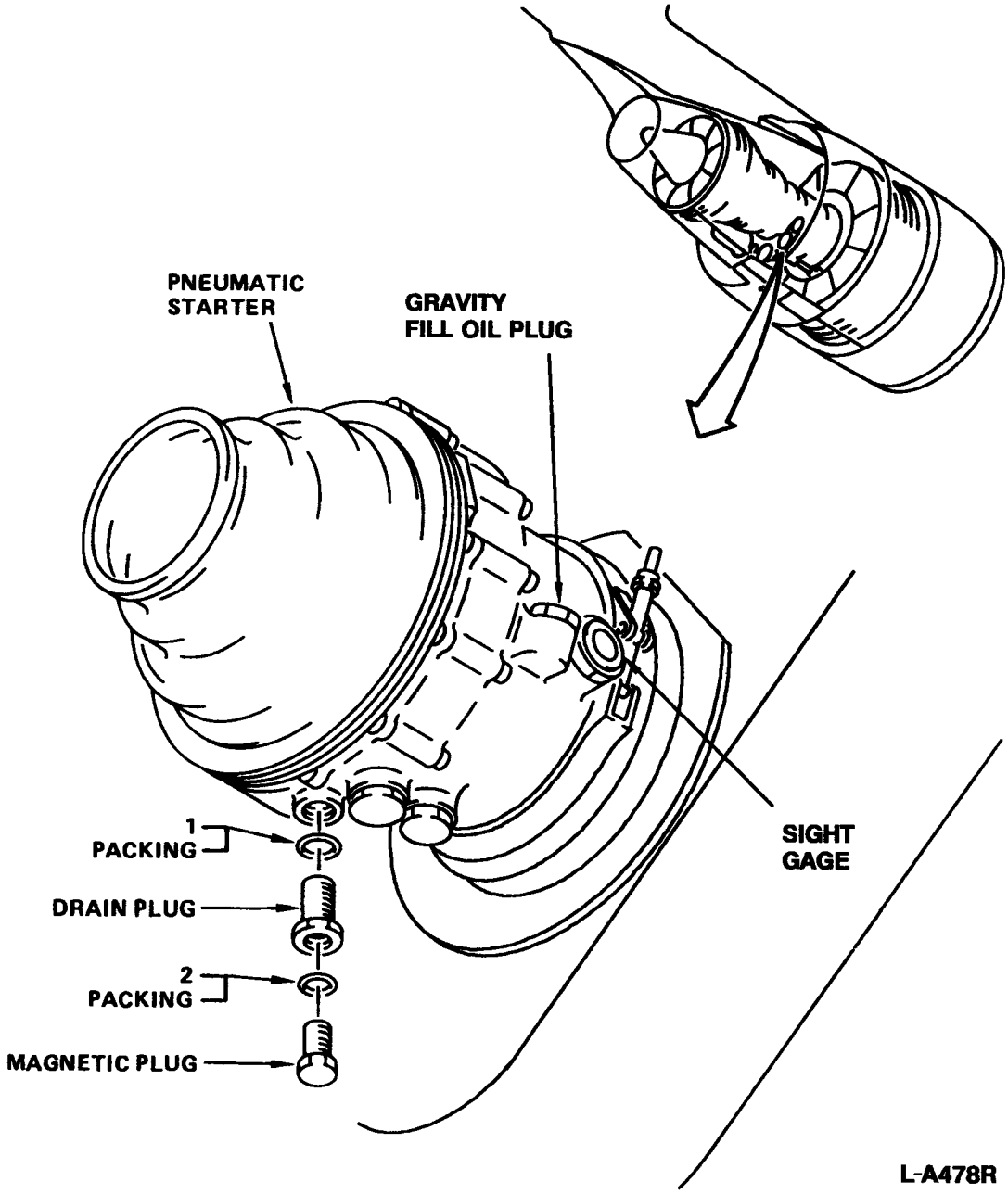
CHIP OR SILVER DEBRIS

L-D3535 (1106)
PW V

BM5 80 13 01 6 KEM0 00

R

Magnetic Chip Collector
Figure 602



BM5 80 13 01 6 KCMO 00

Pneumatic Starter Assy (Non-Pressure Fill Configuration)
Figure 603

PNEUMATIC STARTER SHUTOFF VALVE - REMOVAL/INSTALLATION

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clip
B.	Protective Covers
C.	Pressure Seals
D.	Torque Wrench
Referenced Procedures	
- 71-00-00, P. Block 501	Power Plant - General
- 71-13-00, P. Block 301	Cowl Doors

2. Procedure

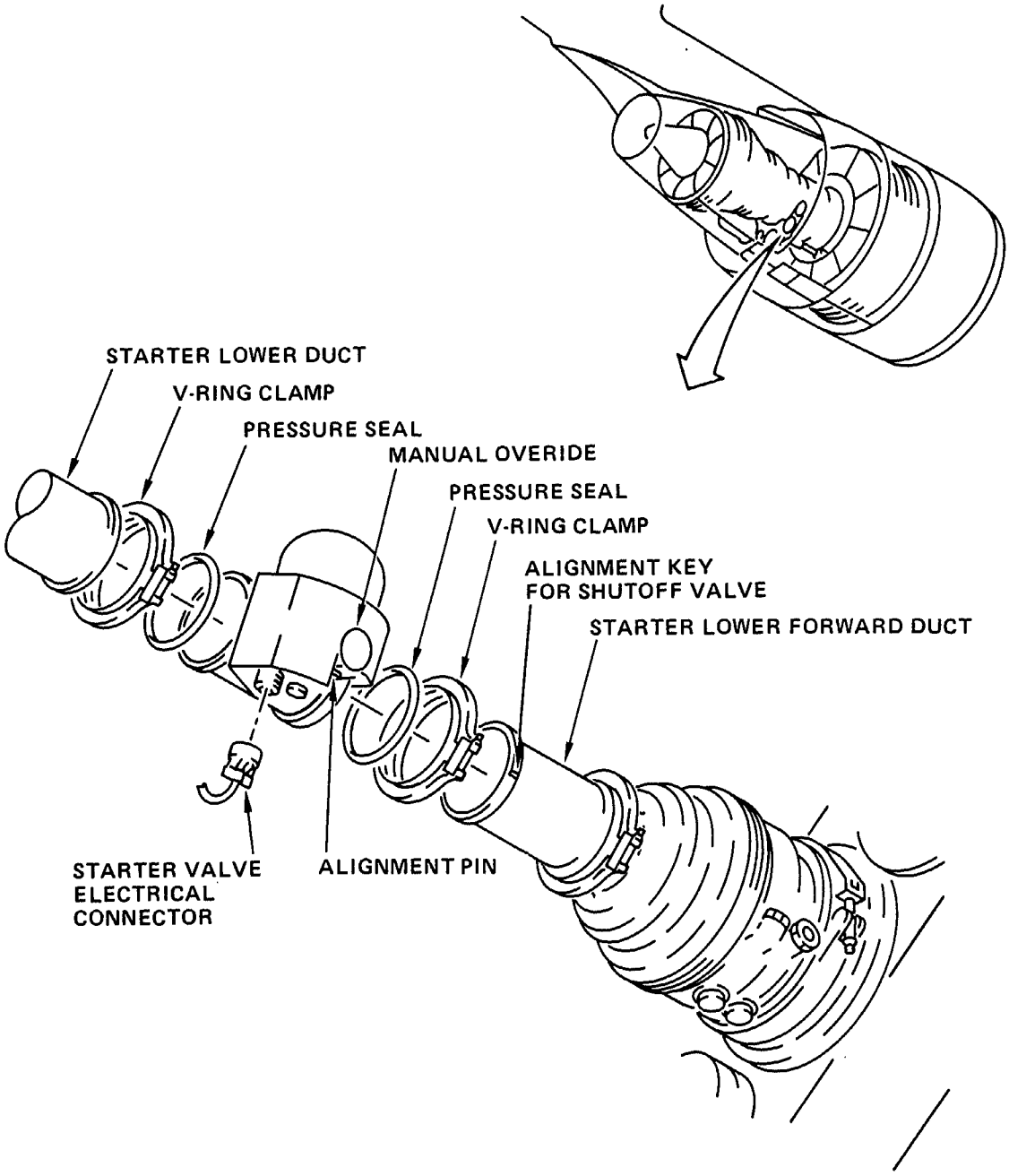
A. Job Set-Up
(1)Open, safety and tag the appropriate circuit breakers and open the fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).
(2)On panel 436VU :
(a)Make certain that the APU Bleed Load Valve Control Switch (17HV) is in OFF position and install a warning notice to tell persons not to use it.
(b)Make certain that the X BLEED VALVE Control Switch (5HV) is in CLOSE position and install a warning notice to tell persons not to use it.
(3)Make certain that there is a warning notice installed on the HP ground connector to tell persons not to use it.

B. Removal (Ref. Fig. 401)
(1)At top of pneumatic starter shutoff valve, remove cooling duct hose.
(2)Disconnect electrical connector DV215 and place protective covers on connector and receptacle.
(3)Remove the two clamps holding electrical cable DV215 to shutoff valve cover.
(4)Remove clamp on shutoff valve cover that secures cable DT597.
(5)Support shutoff valve and unfasten V-ring clamps that secure valve to starter air duct.
(6)Remove shutoff valve.
(7)Discard pressure seals.
(8)Place protective covers on ducts and shutoff valve.

C. Installation (Ref. Fig. 401)
(1)Remove all protective covers
(2)Install pressure seals on mating flanges of starter lower, forward air duct and input of shutoff valve.
(3)Move shutoff valve in position and make certain that alignment notch on input of lower, forward duct mates with alignment key on output of shutoff valve.
(4)Place V-ring clamps on each end of shutoff valve and tighten sufficiently to support weight of valve.
(5)Tap exposed perimeter of V-clamps with brass drift and TORQUE to 120

lbf.in. (1.35 m.daN).
(6) Re-tap exposed perimeter of V-clamps and TORQUE to 120 lbf.in. (1.35 m.daN) Continue procedure until no torque drop is noted.
(7) On side of shutoff valve, install clamp holding cable DT597.
(8) On side of shutoff valve, install the two clamps holding cable DV215.
(9) On top of shutoff valve, install cooling duct hose.
(10) Connect electrical cable DV215 fingertight and then turn an additional one-eighth turn.

D. Close-Up and Test
(1) Remove the warning notices, remove safety clips and tags and close circuit breakers for the appropriate engine (Ref. 71-13-00, P. Block 301).
(2) Perform dry motoring (Ref. 71-00-00, P. Block 501 - Test No. 2), and check start valve for correct operation through illumination of START 1(2) OPEN legend on ENG START panel 429VU.
(3) Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(4) Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301).



BM5 80 13 02 4 KAMO - 01

Pneumatic Starter Shutoff Valve
Figure 401

THRUST REVERSER GROUND SUPPLY PNEUMATIC COUPLING - REMOVAL/INSTALLATION

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Packing
C. Material No.P03-001	Oils (Ref. 70-00-00)
D.	Torque Wrench
E.	Protective Covers
Referenced Procedure - 71-13-00, P. Block 301	Cowl Doors

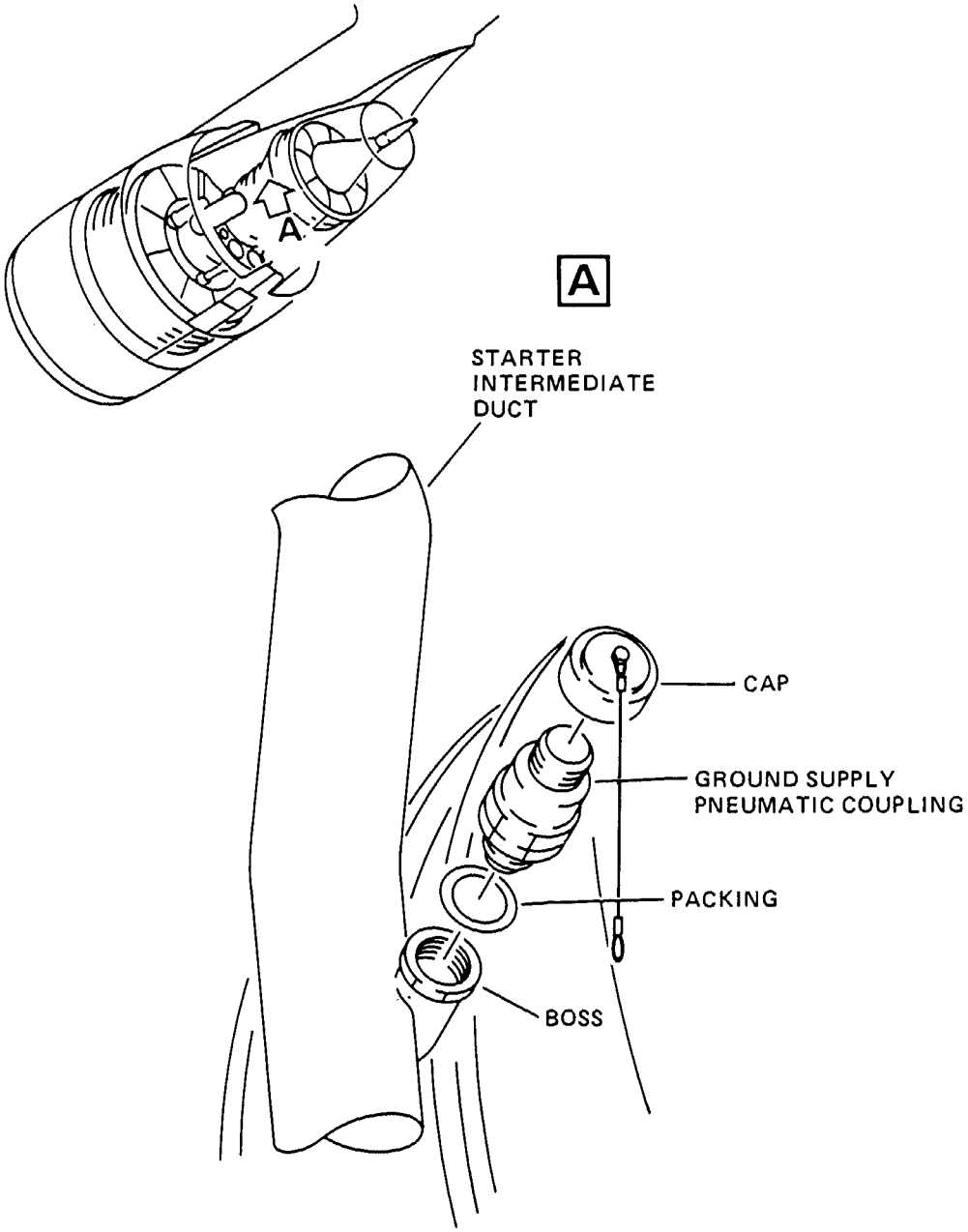
2. Procedure

A. Job Set-Up
(1)Open, safety and tag the appropriate circuit breakers and open the fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).

B. Removal (Ref. Fig. 401)
(1)Disconnect thrust reverse coupling from intermediate air duct at boss and remove.
(2)Discard packing.
(3)Place protective cover on open duct port.

C. Installation (Ref. Fig. 401)
(1)Remove protective cover from pneumatic starter air supply duct port.
(2)Lubricate packing with Material No.P03-001, and position on bottom of thrust reverse coupler.
(3)Install thrust reverse coupler on intermediate air duct boss and TORQUE to between 950 and 1050 lbf.in. (10.74 and 11.86 m.daN).
(4)Install dust cap on coupler.

D. Close-Up
(1)Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(2)Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



BM5 80 13 03 4 KAMO - 19

L-A090R

Thrust Reverser Ground Supply Pneumatic Coupling
Figure 401

THRUST REVERSER GROUND SUPPLY PNEUMATIC COUPLING - INSPECTION/CHECK

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Torque Wrench
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 80-13-03, P. Block 401	Thrust Reverser Ground Supply Pneumatic Coupling

2. Procedure

A. Job Set-Up

(1)Open, safety and tag the appropriate circuit breakers and open the thrust reverser doors (Ref. 71-13-00, P. Block 301).

B. Inspection (Ref. Fig. 601)

(1)Verify that thrust reverser ground supply pneumatic coupling TORQUE is between 950 and 1050 lbf.in. (10.34 and 11.86 m.daN).

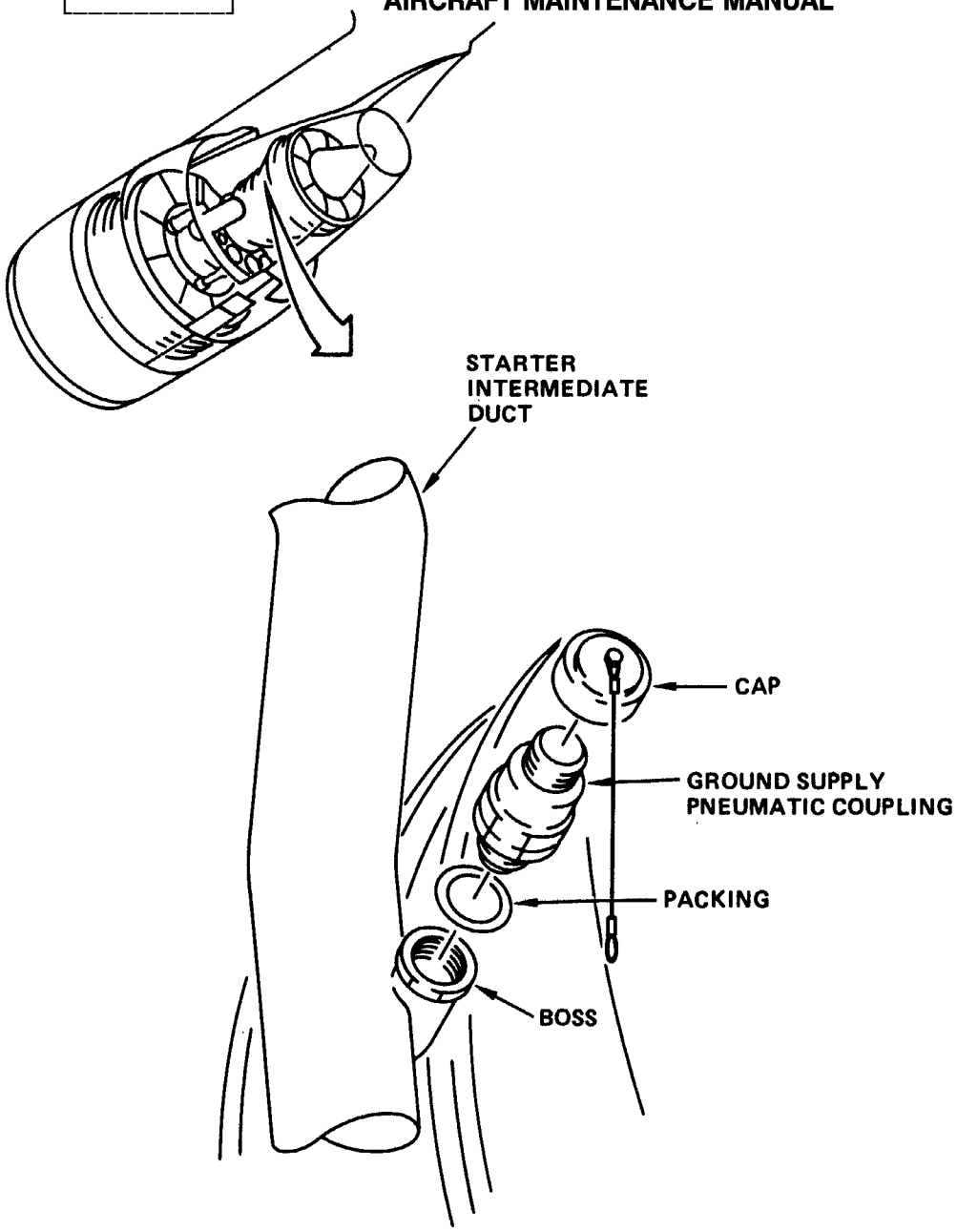
NOTE : If thrust reverser ground supply pneumatic coupling parts must be replaced (Ref. 80-13-03, P. Block 401).

(2)Verify that thrust reverser coupling cap is correctly installed.

(3)Verify that thrust reverser coupling cap retainer cable is fastened to cap and to retainer link.

C. Close-Up

(1)Close thrust reverser cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



BM5 80 13 03 6 KAMO - 20

L–A284R

Thrust Reverser Ground Supply Pneumatic Coupling
Figure 601

PNEUMATIC STARTER QUICK-ATTACH-DETACH (QAD) ADAPTER ASSEMBLY - REMOVAL/INSTALLATION

1. Equipment and Materials

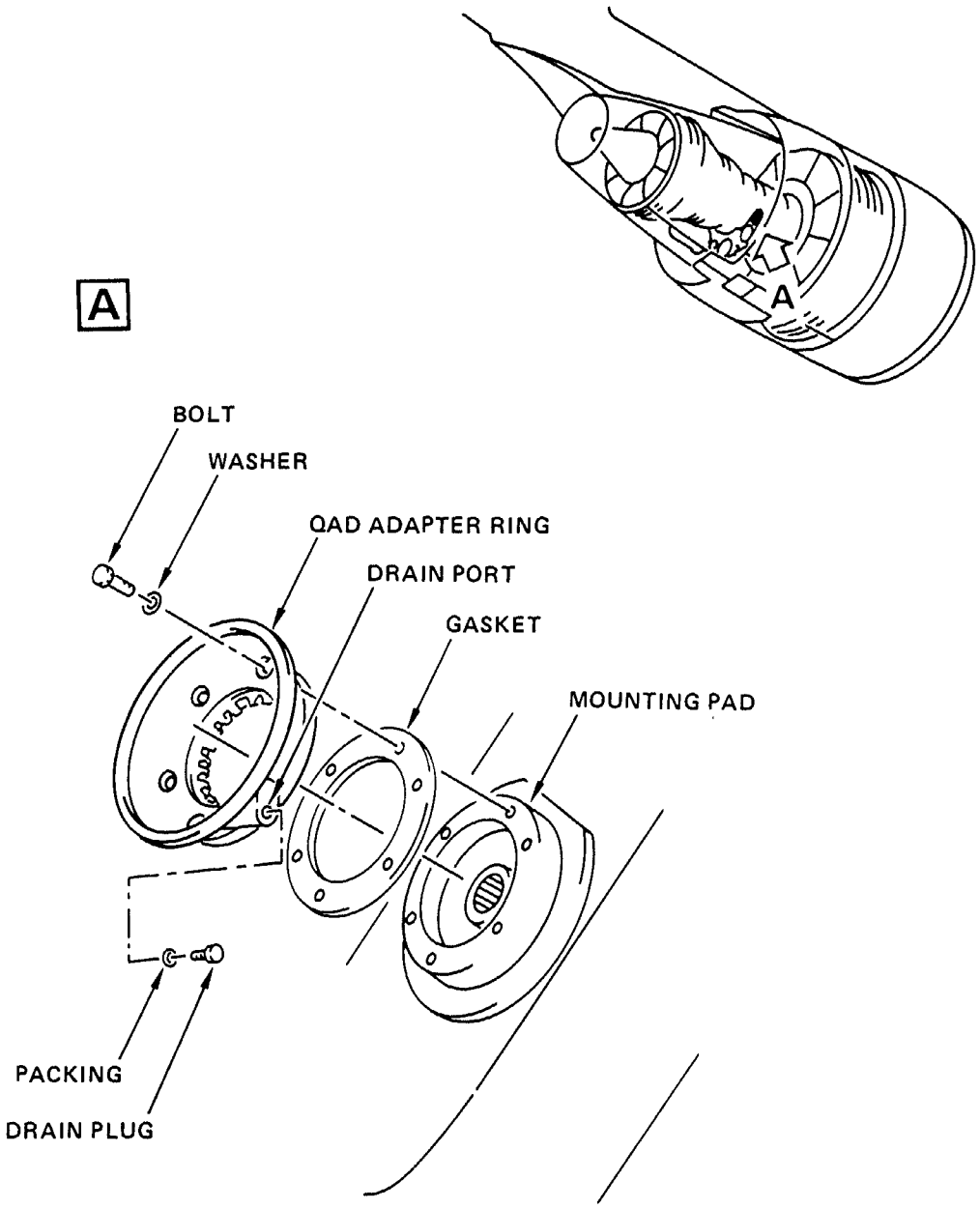
ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B. Material No.P03-001	Oils (Ref. 70-00-00)
R C. Material No.P06-054	Compound, Anti-galling (PWA 586-3)
D.	Packing
E.	Gasket
F.	Torque Wrench
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 72-65-01, P. Block 701	Main Gearbox
- 80-13-01, P. Block 401	Pneumatic Starter Assembly

2. Procedure

A. Job Set-Up
(1)Open, safety and tag the appropriate circuit breakers and open the fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).
(2)Remove pneumatic starter assembly (Ref. 80-13-01, P. Block 401).

B. Removal (Ref. Fig. 401)
NOTE : QAD adapter drain plug and packing were removed when starter was removed (Ref. 80_13-01, P. Block 401).
(1)Remove bolts and washers attaching QAD adapter ring and gasket to mounting pad of accessory drive gearbox.
(2)Remove QAD adapter ring and remove and discard gasket.
(3)Install QAD mounting pad cover with bolts and washers.

C. Installation (Ref. Fig. 401)
(1)Remove QAD mounting pad cover.
NOTE : Before installation, you can clean seal face of main gearbox for coke or scoring (Ref. 72-65-01, P. Block 701).
(2)Lubricate packing with Material No.P03-001 and install packing on drain plug.
(3)Install plug in adapter drain port. TORQUE drain plug to between 110 and 120 lbf.in. (1.24 and 1.36 m.daN).
R (4)Lubricate threads of QAD mounting bolts with Antiseize Compound
R (Material No.P06-054).
(5)Lubricate new gasket with Material No.P03-001.
(6)Position QAD adapter and gasket on mounting pad and make sure that drain plug on QAD adapter is at bottom position.
(7)Install bolts and washers attaching QAD adapter to accessory drive gearbox. TORQUE bolts to between 225 and 255 lbf.in. (2.54 and 2.88 m.daN).
(8)Intall QAD adapter protective cover.



Pneumatic Starter (QAD) Adapter Assembly
Figure 401

D. Close-Up
(1)Install pneumatic starter assembly (Ref. 80-13-01, P. Block 401).
(2)Close thrust reverser and fan cowl doors, remove safety clips and tags and close circuit breakers (Ref. 71-13-00, P. Block 301).

ENGINE START VALVE FILTER - MAINTENANCE PRACTICES

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Corrosion Resistant Steel Lockwire (MS20995C32) (Ref. 70-00-00)
C.	Packing
D.	Filter
Referenced Procedures	
- 70-00-00, P. Block 201	Engine - Standard Practices
- 71-13-00, P. Block 301	Cowl Doors

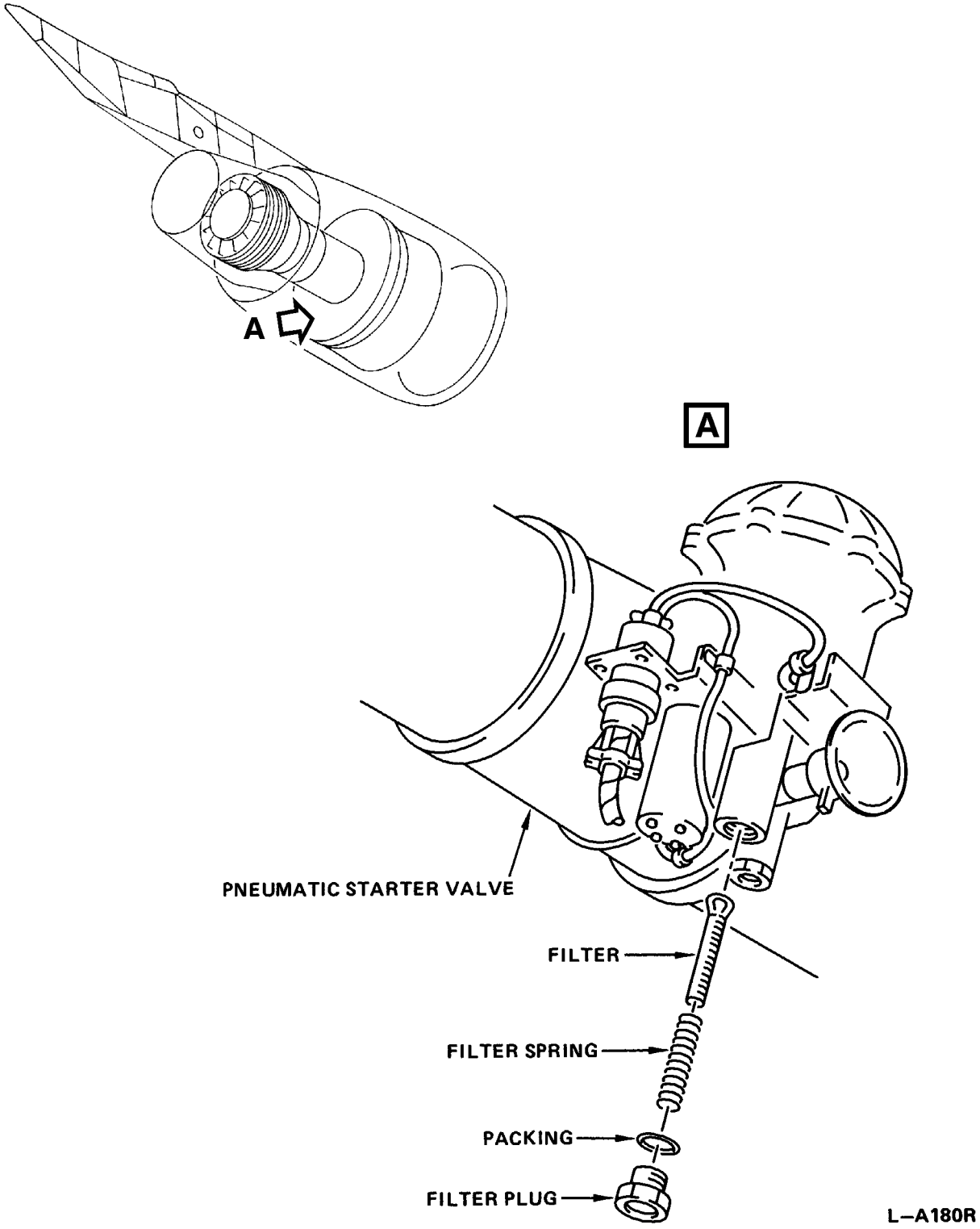
2. Procedure

A. Job Set-Up
(1)Open, safety and tag the appropriate circuit breakers and open fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).

B. Removal (Ref. Fig. 201)
(1)Cut and remove lockwire, unscrew filter plug, and remove filter and filter spring from starter valve. Discard packing.
(2)Clean filter with a SPOP 208 solvent (Ref. 70-00-00, P. Block 201) and blow-dry with dry, filtered air.
(3)Visually check filter for damage. No damage is allowed.

C. Installation (Ref. Fig. 201)
(1)Position filter spring on filter and insert filter into starter valve.
(2)Position new packing on filter plug, install plug in valve and TORQUE plug to between 40 and 45 lbf. in. (0.45 and 0.50 m.daN).
(3)Wirelock filter plug to adjacent plug.

D. Close-Up
(1)Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(2)Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



Engine Start Valve Filter
Figure 201

PNEUMATIC STARTER AIR SUPPLY DUCT - REMOVAL/INSTALLATION

1. Equipment and Materials

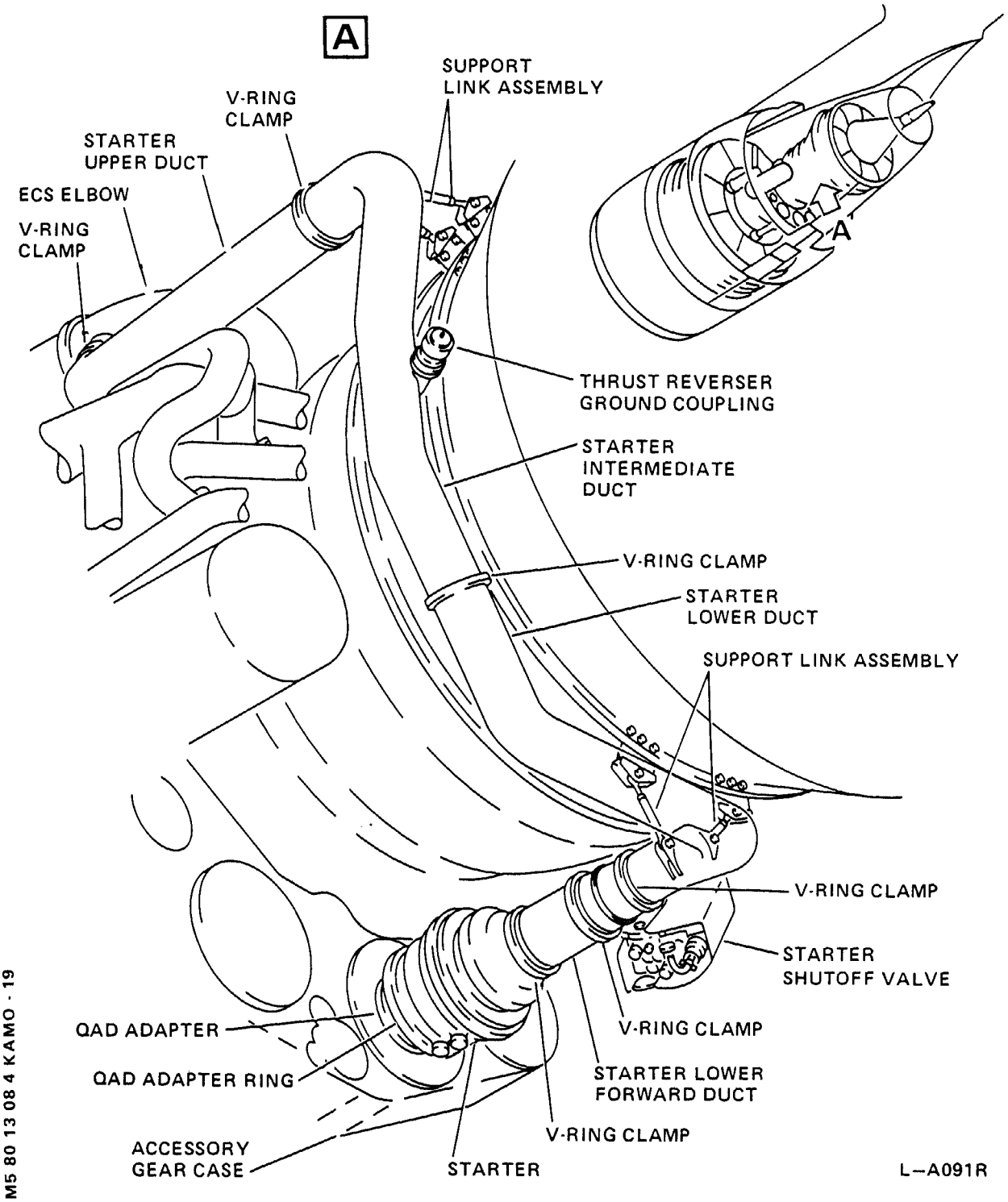
ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Protective Covers
C.	Torque Wrench
D.	Pressure Seals
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 80-13-02, P. Block 401	Pneumatic Starter Shutoff Valve
- 80-13-03, P. Block 401	Thrust Reverser Ground Supply Pneumatic Coupling
- 71-00-00, P. Block 501	Power Plant - General

2. Procedure

A. Job Set-Up
(1)Open, safety and tag the appropriate circuit breakers and open fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).
(2)On panel 436VU :
(a)Make certain that the APU Bleed Load Valve Control Switch (17HV) is in OFF position and install a warning notice to tell persons not to use it.
(b)Make certain that the X BLEED VALVE Control Switch (5HV) is in CLOSE position and install a warning notice to tell persons not to use it.
(3)Make certain that there is a warning notice installed on the HP ground connector to tell persons not to use it.
(4)Remove pneumatic starter shutoff valve. (Ref. 80-13-02, P. Block 401).

B. Removal (Ref. Fig. 401)
(1)Remove starter, lower forward duct section as follows :
(a)Unfasten V-ring clamp that secures duct to starter and remove duct.
(b)Discard pressure seal.
(c)Place protective cover over starter and duct.
(2)Remove starter, lower duct assembly as follows :
(a)Disconnect both suppport link assemblies at mounting bracket on lower duct and move aside.
(b)Support lower duct and unfasten V-ring clamp that secures duct to intermediate duct.
(c)Remove lower duct.
(d)Discard pressure seal.
(3)Remove intermediate duct assembly as follows :
(a)Disconnect both support link assemblies at mounting bracket on top of intermediate duct and move aside.
(b)Support intermediate duct and remove V-ring clamp that fastens intermediate duct to upper duct.
(c)Remove intermediate duct.
(d)Discard pressure seal.

(4)Remove upper duct assembly as follows :
(a)At in-board side of duct, unfasten all sense lines clamps.
(b)Support duct and remove V-ring clamp that fastens upper duct to ECS duct assembly.
(c)Remove upper duct assembly.
(d)Discard pressure seal.



Pneumatic Starter Air Supply Duct
Figure 401

C. Installation (Ref. Fig. 401)

CAUTION : A NEW PRESSURE SEAL MUST BE INSTALLED WHEN-EVER A V-RING CLAMP IS LOOSENED OR REMOVED.

(1)Remove all protective covers.

(2)Install upper, duct assembly as follows :

(a)Install pressure seal on mating flanges between upper duct and ECS duct assembly.

(b)Align duct to approximate position.

(c)Support in position and fasten V-ring clamp that secures upper duct to ECS duct assembly. Tighten sufficiently to support duct and allow final alignment to be made by hand.

(3)Install intermediate duct assembly as follows :

(a)Position pressure seal on mating flanges between intermediate duct and upper duct.

(b)Align duct to approximate position.

(c)Support intermediate duct in position and fasten V-ring clamp that secures intermediate duct to upper duct. Tighten sufficiently to support duct and allow final alignment to be made by hand.

(d)At top of intermediate duct, install both support link assemblies to temporarily support weight of upper and intermediate duct. Adjust support link 1/2 turn shorter than no-preload length to provide slight tension.

(4)Install lower, forward duct assembly as follows :

(a)Install pressure seal on mating flanges between starter and duct.

(b)Position duct so that alignment keys on starter and duct are mated.

(c)Install V-ring clamp on starter end of duct and fasten sufficiently to hold duct in position.

(d)Tap exposed perimeter of V-clamp with brass drift and TORQUE to 120 lbf. in. (1.35 m.daN).

(e)Re-tap and re-torque V-clamp to 120 lbf. in. (1.35 m.daN). Continue procedure until no torque drop is noted.

(5)Install starter pneumatic shutoff valve as follows :

(a)Install pressure seal on mating flanges of starter lower, forward air duct input and output of shutoff valve.

(b)Hold shutoff valve in position and ensure that alignment keys on input of duct and output of shutoff valve are mated.

(c)Place V-ring clamp on mated flanges of duct and valve and tighten sufficiently to support weight of valve.

(d)Tap exposed perimeter of V-clamp with brass drift and TORQUE to 120 lbf. in. (1.35 m.daN).

(e)Re-tap exposed perimeter of V-clamp and re-torque to 120 lbf. in. (1.35 m.daN). Continue procedure until no torque drop is noted.

(f)On side of shutoff valve, install clamp holding cable DT597.

(g)On side of shutoff valve, install the two clamps holding cable DV215.

(h)On top of shutoff valve, install cooling duct hose.

(i)Remove protective covers from electrical connector DV215 and receptacle.

(j)Connect electrical cable DV215 fingertight and then turn an additional one-eighth turn.

(6)Install lower duct assembly as follows :

(a)Position pressure seals on mating flanges at input and output of lower duct.
(b)Position lower duct between intermediate duct and shutoff valve and fasten V-ring clamps sufficiently to support duct and allow alignment to be made by hand.

(7)Starting with the uppermost duct, align the upper, intermediate, and lower ducts to ensure that each follow the designed, preformed route without twisting or warping.

(8)Torque V-ring clamp that fastens output of lower duct to input of shutoff valve as follows :
(a)Hold joint to prevent movement and tighten V-ring clamp until mating flanges cannot be moved by hand.
(b)Tap exposed perimeter of V-clamp with brass drift and TORQUE to 120 lbf. in. (1.35 m.daN).
(c)Re-tap and re-torque V-clamp to 120 lbf. in. (1.35 m.daN). Continue procedure until no torque drop is noted.

(9)Torque V-ring clamp that fastens input of lower duct to output of intermediate duct as follows :
(a)Hold joint to prevent movement and tighten V-ring clamp until mating flanges cannot be moved by hand.
(b)Tap exposed perimeter of V-clamp with brass drift and TORQUE to 120 lbf. in. (1.35 m.daN).
(c)Re-tap and re-torque V-clamp to 120 lbf. in. (1.35 m.daN). Continue procedure until no torque drop is noted.

(10)Torque V-ring clamp that fastens intermediate duct to upper duct as follows :
(a)Hold joint to prevent movement and tighten V-ring clamp until mating flanges cannot be moved by hand.
(b)Tap exposed perimeter of V-clamp with brass drift and TORQUE to 120 lbf. in (1.35 m.daN).
(c)Re-tap and re-torque V-clamp to 120 lbf. in. (1.35 m.daN). Continue procedure until no torque drop is noted.

(11)Torque V-ring clamp that fastens upper duct to ECS duct assembly as follows :
(a)Hold joint to prevent movement and tighten V-ring clamp until mating flanges cannot be moved by hand.
(b)Tap exposed perimeter of V-clamp with brass drift and TORQUE to 120 lbf. in. (1.35 m.daN).
(c)Re-tap and re-torque V-clamp to 120 lbf. in. (1.35 m.daN). Continue procedure until no torque drop is noted.

(12)Adjust length of support link assemblies at top of intermediate duct 1/2 turn shorter than no-preload length to provide slight tension and fasten them to duct support bracket.
(13)TORQUE nuts to between 50 to 70 lbf. in. (0.57-0.79 m.daN) and lock.
(14)Adjust length of lower duct support link assemblies to relieve any preload and attach to lower duct support bracket.
(15)TORQUE nuts to between 50 to 70 lbf. in. (0.57-0.79 m.daN) and lock.
(16)Install clamps that fasten sensing lines behing upper duct.
(17)If previously removed, install thrust reverser ground supply pneumatic coupling. (Ref. 80-13-03, P. Block 401).

D. Close-Up
(1)Remove the warning notices, remove safety clips and tags and close circuit breakers (Ref. 71-13-00, P. Block 301).
(2)Dry motor engine and check for air leakage (Ref. 71-00-00, P. Block 501).
(3)Make certain that working area in clean and clear of tools and miscellaneous items of equipment.
(4)Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301).

PNEUMATIC STARTER AIR SUPPLY DUCT - INSPECTION/CHECK

1. Equipment and Materials

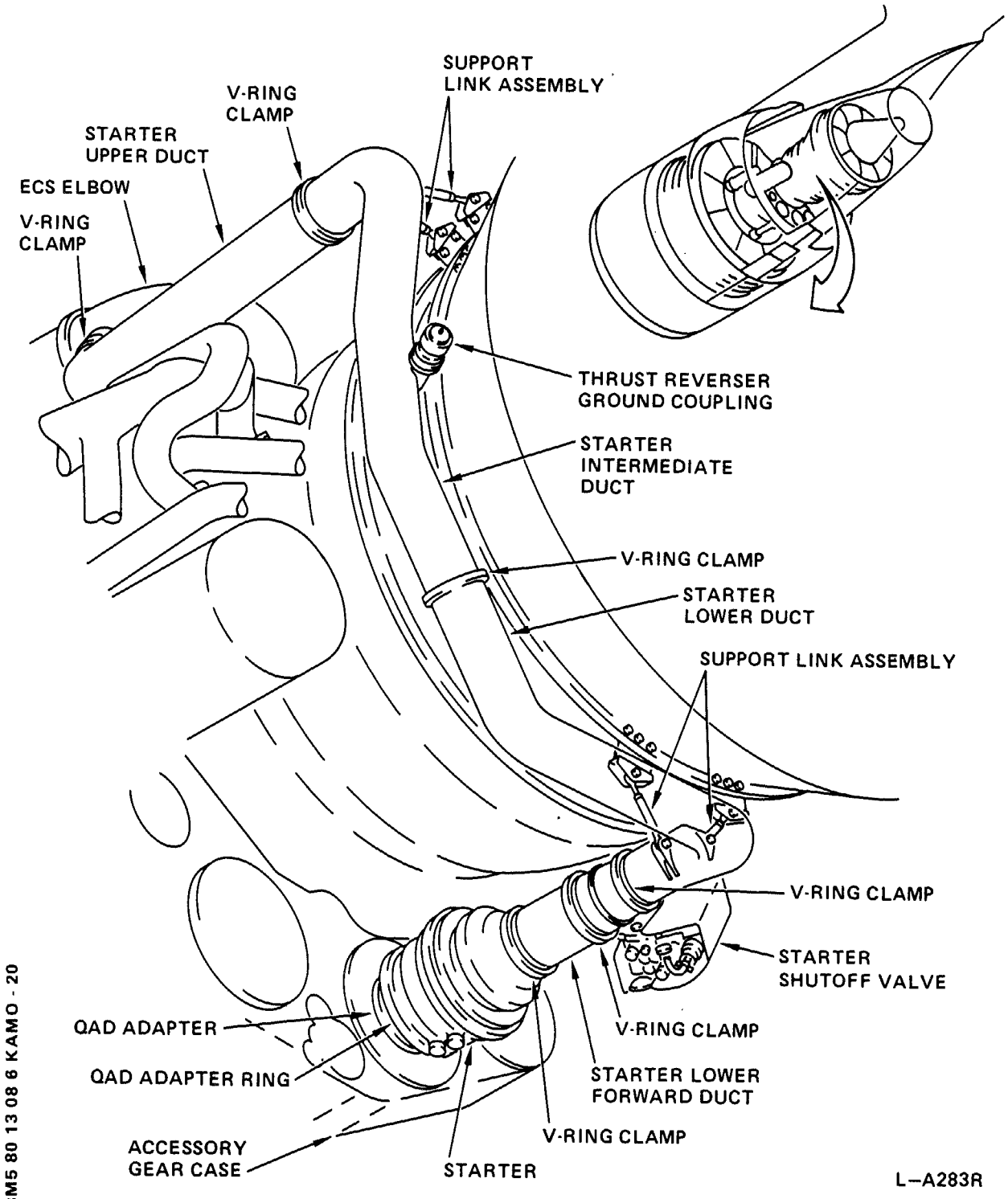
ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 80-13-08, P. Block 401	Pneumatic Starter Air Supply Duct

2. Procedure

A. Job Set-Up
(1)Open, safety and tag the appropriate circuit breakers, and open the thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).

B. Inspection (Ref. Fig. 601)
(1)Visually inspect starter duct for the following conditions :
(a)Loose ducts. If loose ducts are noted, check for broken, loose or improper alignment of support links, brackets or V-clamps, that secure sections of ducts, starter and shutoff valve. To align or replace parts (Ref. 80-13-08, P. Block 401).
(b)Holes or cracks. If holes or cracks are noted, regardless of size, the duct assembly must be replaced (Ref. 80-13-08, P. Block 401).
(c)Dents, twists, bends or damage. If damage or deformities of any magnitude are noted, the duct assembly must be replaced (Ref. 80-13-08, P. Block 401).
(d)Support link assemblies. Inspect support link assemblies, mounting brackets on engine flanges and duct assemblies for looseness, misalignment, breaks, bends or other deformities. Any malfunction must be corrected and broken parts replaced (Ref. 80-13-08, P. Block 401).

C. Close-Up
(1)Close the thrust reverser cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



Pneumatic Starter Air Supply Duct System
Figure 601

PNEUMATIC STARTER COOLING AIR TUBE - REMOVAL/INSTALLATION

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Torque Wrench
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 80-13-01, P. Block 401	Pneumatic Starter Assy

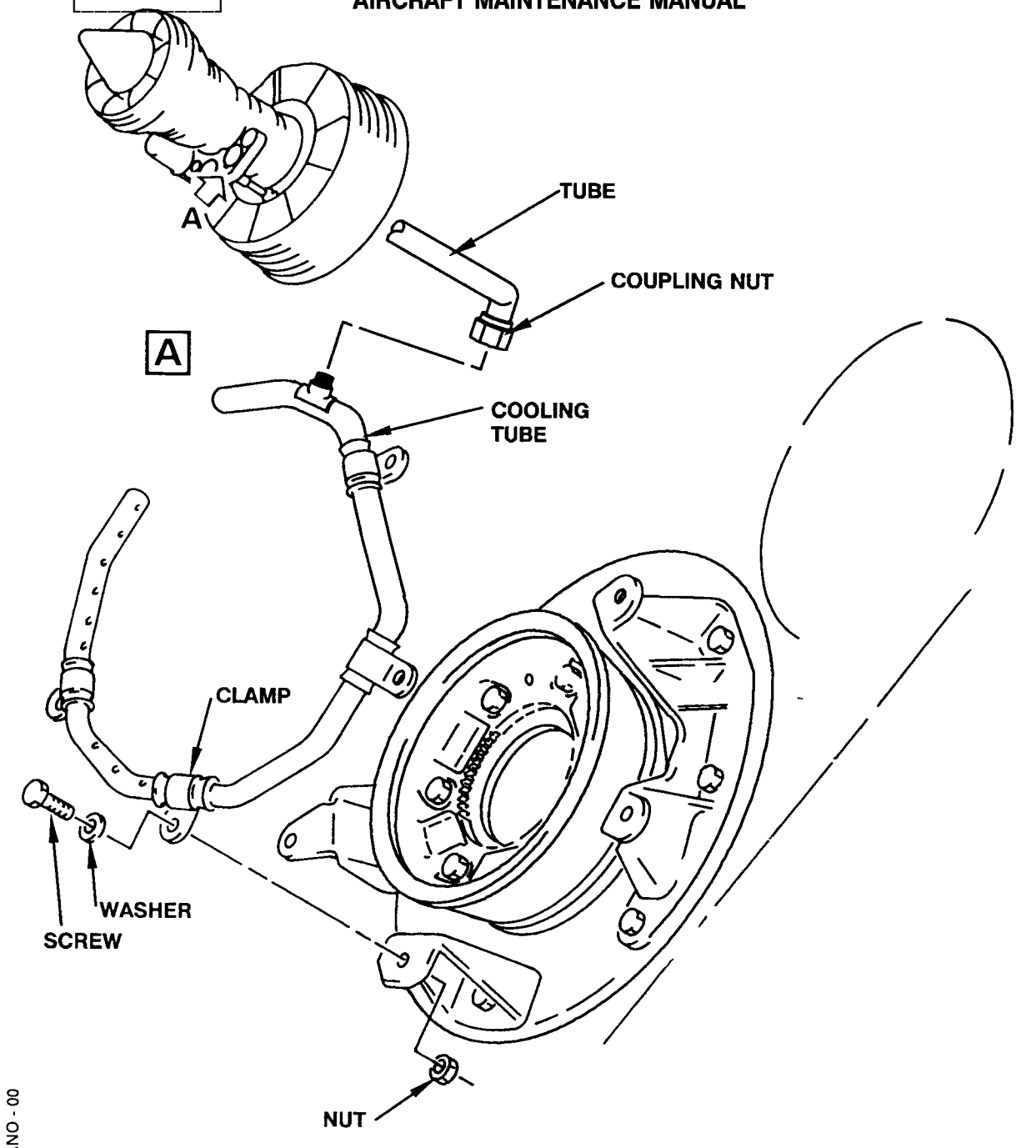
2. Procedure (Ref. Fig. 401)

A. Job Set-Up
(1) Open, safety and tag the appropriate circuit breakers and open the fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).
(2) Remove pneumatic starter assembly (Ref. 80-13-01, P. Block 401).

B. Removal
(1) Loosen cooling tube coupling nut to disconnect tubes.
(2) Remove four bolts, washers, nuts and clamps attaching cooling air tube assembly to mounting brackets and remove assembly.

C. Installation
(1) Position pneumatic starter cooling tube assembly and clamps on mounting brackets and attach with bolts, washers and nuts. Finger tighten nuts only at this time.
(2) Position pneumatic starter cooling air tube assembly to mate with tube coupling nut. TORQUE coupling nut to between 450 and 500 lbf. in. (5.08 and 5.65 m.daN).
(3) TORQUE nuts installed in step (1) to between 20 and 25 lbf. in. (0.23 and 0.28 m.daN).

D. Close-Up
(1) Install pneumatic starter assembly (Ref. 80-13-01, P. Block 401).
(2) Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(3) Close thrust reverser and fan cowl doors (Ref. 71-13-00, P. Block 301). Remove safety clips and tags and close circuit breakers.



BM5 80 13 09 4 KANO - 00

Pneumatic Starter Cooling Air Tube Assembly
(Post SB PW4NAC 75-9)
Figure 401

PNEUMATIC STARTER HEATSHIELD ASSEMBLY - REMOVAL/INSTALLATION

1. Equipment and Materials

ITEM	DESIGNATION
A.	Circuit Breaker Safety Clips
B.	Torque Wrench
Referenced Procedures	
- 71-13-00, P. Block 301	Cowl Doors
- 80-13-01, P. Block 401	Pneumatic Starter Assy
- 80-13-09, P. block 401	Pneumatic Starter Cooling Air Tube

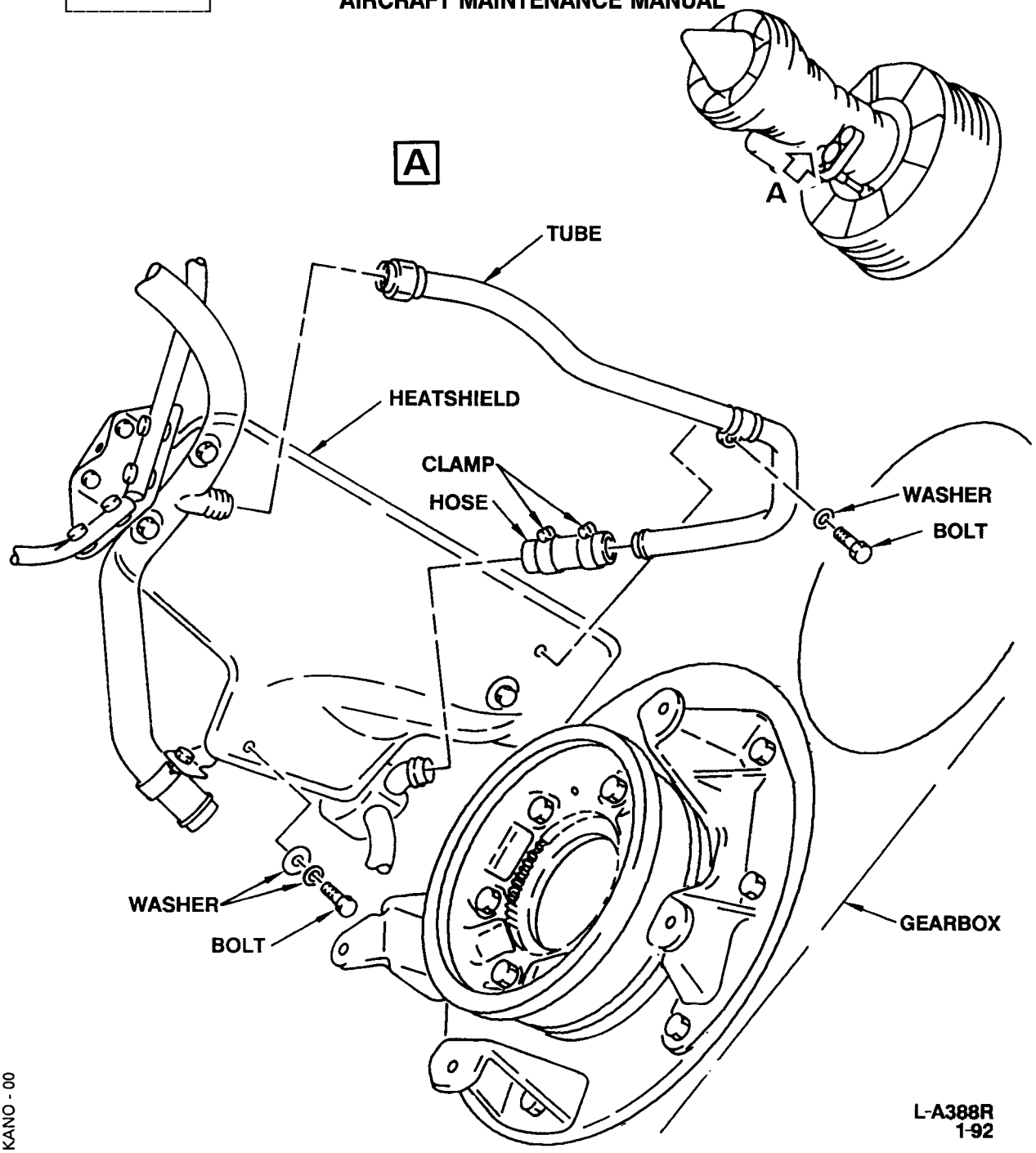
2. Procedure (Ref. Fig. 401)

A. Job Set-Up
(1) Open, safety and tag the appropriate circuit breakers and open the fan and thrust reverser cowl doors (Ref. 71-13-00, P. Block 301).
(2) Remove pneumatic starter assembly (Ref. 80-13-01, P. Block 401).
(3) Remove pneumatic starter cooling tube (Ref. 80-13-09, P. Block 401).

B. Removal
(1) Remove clamp attaching hose to permanent magnet alternator (PMA) cooling tube.
(2) Remove PMA cooling tube coupling nut from ignition cooling duct.
(3) Remove bolt, washer, and nut attaching PMA cooling tube clamp to heatshield assembly and remove PMA cooling tube.
(4) Remove four screws and washers attaching pneumatic starter heatshield assembly to mounting brackets and remove heatshield.

C. Installation
(1) Position pneumatic starter heatshield on the mounting brackets and attach with four screws and washers. TORQUE screws to between 50 and 70 lbf.in. (0.57 and 0.79 m.daN).
(2) Position PMA cooling tube and attach to heatshield assembly with bolt, washer, and nut. TORQUE nut to between 20 and 25 lbf.in. (0.23 and 0.28 m.daN).
(3) Connect PMA cooling tube coupling nut to ignition cooling duct. TORQUE coupling nut to between 450 and 500 lbf.in. (5.08 and 5.65 m.daN).
(4) Connect PMA cooling tube to hose and TORQUE hose clamp to between 25 and 30 lbf.in. (0.28 and 0.34 m.daN).

D. Close-Up
(1) Install pneumatic starter cooling tube assembly (Ref. 80-13-09, P. Block 401).
(2) Install pneumatic starter assembly (Ref. 80-13-01, P. Block 401).
(3) Make certain that working area is clean and clear of tools and miscellaneous items of equipment.
(4) Close thrust reverser and fan cowl doors (Ref. 71-13-00,P. Block 301). Remove safety clips and tags and close circuit breakers.



Pneumatic Starter Heatshield Assembly
(Post SB PW4NAC 75-9)
Figure 401